# 6160B

FLUKE®

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# Instruction Manual

Model

# 6160B

## Frequency Synthesizer

P/N 382028

Rev. 1 7/74

OCTOBER 1973

: LABORATORIES INC.

FLUKE®

# Instruction Manual

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Rev. 12/77

# Change/Errata Information

**Issue No:** 2 8/78

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual if either one of the following conditions exist:

1. The instrument's PCB revision letter is lower than that which is indicated at the beginning of the change/errata.

2. No revision letter is indicated at the beginning of the change/errata.

## MANUAL

**Title:** MODEL 6160B FREQUENCY SYNTHESIZER

**Print Date:** OCTOBER 1973

**Rev and Date:** 1 – 7/74

**C/E PAGE EFFECTIVITY**

| Page No. | Print Date |
|---|---|
| 1 | 10/77 |
| 2 | 8/78 |

ERRATA #1

On page 5-48, change the description, Fluke stock no, and mfg part no for inductor L5
From: 3.3 uh, 174714, WEE3.3
To: 33 uh, 207563, WEE33

ERRATA #2

On page 4-9, add the following note after paragraph heading 4-34, MODULE ALIGNMENT.

*NOTE*

*In the following procedures manually applied 8–4–2–1 commands should be tied to either high (+5V dc through 1 kΩ) or low (logic common) logic levels. Tie all unspecified command lines high.*

CHANGE #1 – 7853

On page 5-72, delete Q5 from Q3, Q4, Q5 and change the total qty for the entry from 17 to 15.

On page 5-72 add Q5 and Q15 to Q14 and change the tot qty from 5 to 7.

CHANGE #2 – 8978

On page 5-11, chnage the Fluke stock no, mfg fed sply cde, and mfg part no
From: 309617, 71318, FLV102
To: 428623, 12040, 59NSL-5046

CHANGE #3 – 10853

On page 5-54 delete R3 from R3, R4 and change the tot qty from 5 to 4.

On page 5-54 add R3 to R26 and change the description, Fluke stock no, mfr part no, and tot qty
From: 330Ω, 147967, CB3315, 1
To: 51Ω, 221879, CB5105, 2

On page 5-58, change the description, Fluke stock no, mfr part no, and tot qty of resistor R1
From: 820Ω, 148015, CB8215, 3
To: 1.1KΩ, 267336, CB1025, 1.

On page 5-59 change the tot qty of R18 from REF to 2.

On page 8-12, change the value of resistor R3 from 330 (Ω) to 51 (Ω).

On page 8-13, change the value of resistor R1 from 820 (Ω) to 1.1K (Ω).

CHANGE #4 – 10996

On page 5-58, make the following changes:
Fluke stock no and mfr part no of L1, L3 from 207605, WEE-.33 to 261735, WEE-.22.
Fluke stock no of L2 from 321018 to 313031.

On page 8-13, change the value of inductor L1 and L3 from .33 to .22.

CHANGE #5 – 11119

On page 5-76, change the tot qty of IC U3 from 1 to 2.

On page 5-77, make the following changes:
Fluke stock no, mfg part no, and tot qty of U17
From: 293068, SN 74H00P, 2
To: 363580, SN 74S00P, REF.
Fluke stock no and mfg part no of U18
From: 340448, SN74H11N
To: 363457, SN74S11N.
Tot qty of U31 from REF to 1.

CHANGE #6 – 11406

On Final Assembly page 5 - 4 and 5 - 5, make the following changes:

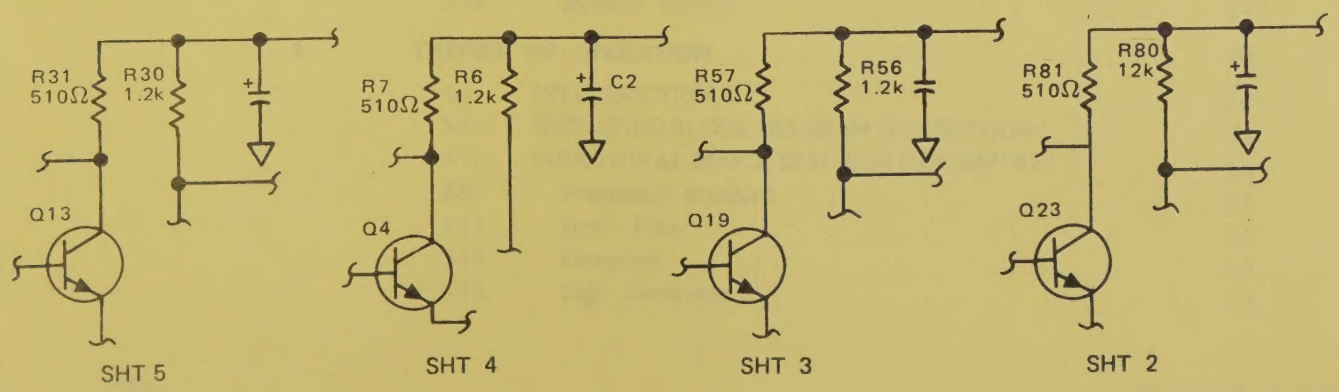
| | | | | |
|---|---|---|---|---|
| | / 394320/ | | 394320/ | |
| 6/ Decal corner/ | ~~296277~~/ | 89536/ | ~~296277~~/ | 4 |
| | /394361/ | | /394361/ | |
| 15/Corner, rear/ | ~~295998~~/ | 89536/ | ~~295998~~/ | 2 |

CHANGE #7 – 11685

Rev - N, Six Digit Generator PCB Assembly, make the following changes:
Delete the following items; R7, R31, R57, and R81.
Change TOT QTY of item R6 from 10 to 6
Add: R7, R31, R57, R81 /Res, comp, 510, ±5%, ¼W/ 218032/ 01121/ CB5115/ 4
Change items; U1, U5, U18, U25, U30, U44 and U47 as indicated:

| | | | | | |
|---|---|---|---|---|---|
| | | /363457/ | | / SN74S11 | /1 |
| IC, TTL, triple 3-input Pos AND gate/ | ~~340448~~/ | 01295/ | ~~S10741111N~~/ | ~~7~~ | |

On Figure 8-13, make the following changes:



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Section 1

# Introduction & Specifications

## 1-1 INTRODUCTION

1-2. The Model 6160B Frequency Synthesizer produces a selectable signal of 1 to 160 MHz in two separate ranges: 1 to 12 MHz and 10 to 160 MHz. Resolution is 0.1 Hz in the 1 to 12 MHz range and 1 Hz in the 10 to 160 MHz range. The output signal level is adjustable from +3 to +13 dBm into 50 ohms using either a control on the front panel or a dc control voltage applied to a connector on the rear panel. The output signal level will be maintained to within ±1 db.

1-3. Output frequency selection can be done directly from the front panel or electrically through a remote connector on the rear panel. Remote control input requirements are compatible with DTL or TTL logic using BCD coding. Logic levels are as follows:

Logic "0" = 0 to +0.9V dc or contact closure to logic ground. Maximum per line current sinking requirement is 1.6 ma.

Logic "1" = +2 to +5V dc.

1-4. The synthesizer is completely solid-state and modular construction is used throughout for ease in maintenance. The chassis is designed for bench-top use or installation in a standard 19 inch equipment rack. Rack mounting brackets and chassis slides are available for rack mounting. Input power requirement is 115/230V ac ±10%, 50 to 440 Hz at approximately 80 watts.

1-5. Optional features are available to meet specific applications. These options are described in Table 1-1.

Table 1-1. OPTIONS

| OPTION | DESCRIPTION |
|---|---|
| –02 | Internal 5 MHz Standard. 2 X $10^{-9}$ per day drift rate |
| –04 | Rear Output. BNC output connector on rear panel. |
| –05 | Temperature Compensated Crystal Oscillator. 5 X $10^{-6}$ per year drift rate. |

## 1-6. SPECIFICATIONS

**FREQUENCY**

| | | |
|---|---|---|
| RANGES | 1 MHz to 12 MHz | 10 MHz to 160 MHz |
| INCREMENTS | 0.1 Hz | 1 Hz |
| SELECTION | Front panel rotary switches, remote BCD-TTL or DTL positive true logic or contact closures. Logic "0" = 0 to +.9V dc. Logic "1" = +2 to +5V dc, or open circuit. | |

**SPURIOUS OUTPUTS**

| | |
|---|---|
| NON-HARMONIC | Greater than 83dB (to 100dB) below fundamental. See Figure 1-1. |
| HARMONICS | Greater than 25dB below fundamental. (Typically >30 dB) |

**SIGNAL TO NOISE RATIO (TYPICAL)**
(Including the effects of the internal standard)

| | | |
|---|---|---|
| PHASE | Greater than 62 dB | |
| AMPLITUDE | Greater than 94 dB | Measured in a 30 kHz band excluding a 1 Hz band centered on the fundamental, for dialed frequencies from 80 MHz to 160 MHz. Improvement in signal to phase noise ratio is seen for lower frequencies. |
| SYNTHESIZER RESIDUAL (Internal noise from 5 MHz input to synthesizer output) | | |
| PHASE | Greater than 74 dB | |
| AMPLITUDE | Greater than 94 dB | |

**PHASE NOISE SPECTRAL DENSITY** . . . . . Guaranteed SSB S/N ratio at the synthesizer output measured in a 1 Hz bandwidth. Valid for dialed frequencies from 80 MHz to 160 MHz. Improvement for lower selected frequencies.

| OFFSET FREQUENCY | GUARANTEED S/N |
|---|---|
| 1.2 kHz | ⟩115dB |
| 32 kHz | ⟩121dB |
| 600 kHz | ⟩135dB |

**OUTPUT VOLTAGE**

1 MHz - 160 MHz . . . . . Adjustable from +3 dBm to +13 dBm into 50Ω (.3V to 1V rms) with front panel control or external dc voltage. Level maintained ±1 dB into 50Ω

**SWITCHING TIME** . . . . . Less than 800μsec to be within 50 Hz of final frequency.

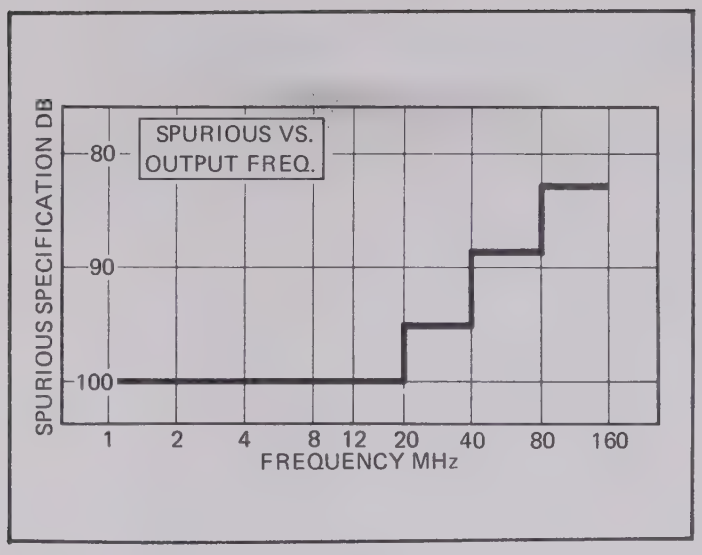
**INTERNAL FREQUENCY STANDARD (Optional)** . . . 5 MHz

| OPTION | AGING RATE | TEMPERATURE STABILITY |
|---|---|---|
| –02 | $\pm 2 \times 10^{-9}$/Day | $1 \times 10^{-8}$, 0°C to 50°C |
| –05 | $5 \times 10^{-6}$/Year | $1 \times 10^{-6}$, 0°C to 50°C |

**AUXILIARY OUTPUTS** . . . . . 5 MHz at nominally 1V rms into 50Ω.

**AUXILIARY INPUTS**

| | |
|---|---|
| Reference Frequency | 5 MHz @ 0 dBm to +16 dBm into 50Ω |
| External Level Control | 0.1 to 0.8 VDC nominal into > 2 kΩ |




*NOTE*

*Power line related spurious may exceed these specifications when unit is powered from 50 Hz, high line voltage source.*

Figure 1-1. NON-HARMONIC SPURIOUS PERFORMANCE

**POWER REQUIREMENTS** . . . . . 115/230V rms ±10% selectable by rear panel switch, 50 – 440 Hz, 80 watts.

**DIMENSIONS, WEIGHT** . . . . . Standard 19" (48.3 cm) relay rack width, 7" (17.8 cm) high, 20" (50.8 cm) behind front panel, 45 pounds (21 kg). Slides and rack mounting kit optional (See outline drawing, Figure 1-2).

**ENVIRONMENTAL**

OPERATING . . . . . 0 to 50°C, 0 to 80% RH, 0 to 10,000 feet.
NON-OPERATING . . . . . –62°C to +70°C, 0 to 50,000 feet.

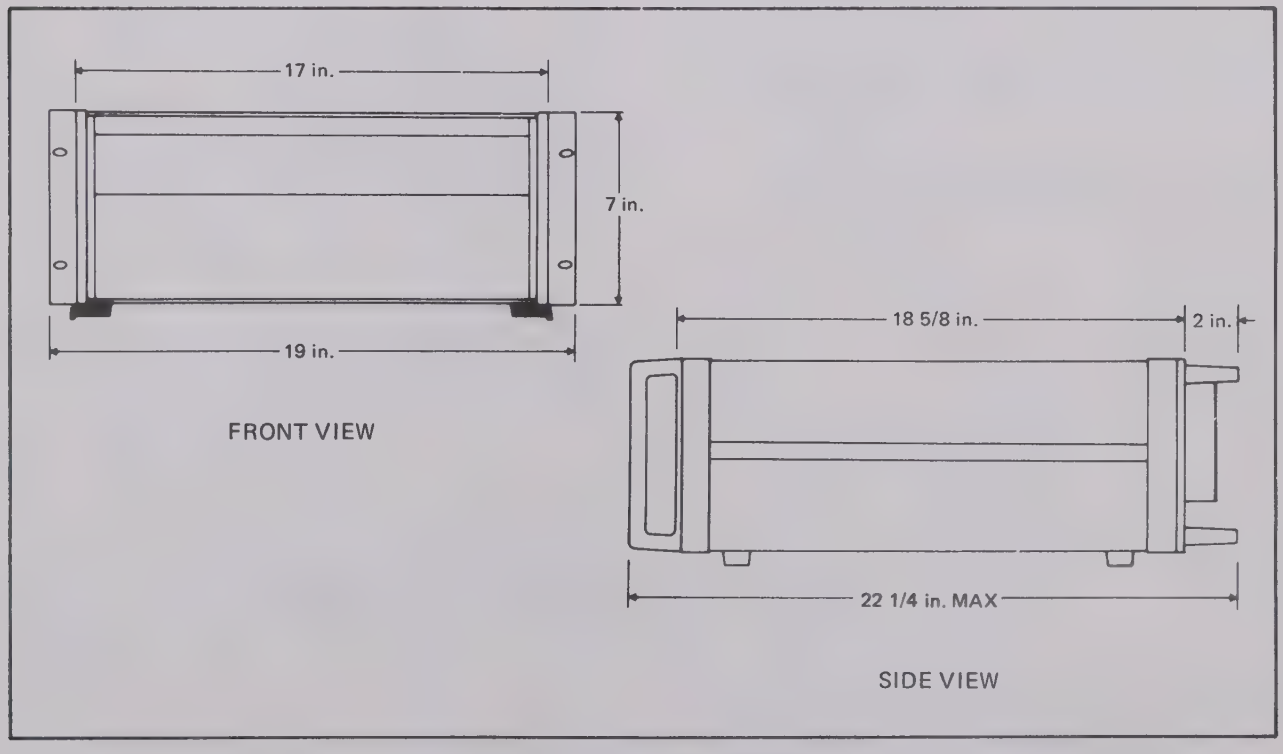



Figure 1-2. OUTLINE DRAWING

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Section 2

# Operating Instructions

## 2-1. INTRODUCTION

2-2. This section contains information essential for correct operation of the Model 6160B. Should any difficulties be encountered during operation, please contact the nearest John Fluke Sales Representative or the John Fluke Mfg. Co., Inc. A complete list of Sales Representatives is located at the rear of this manual.

## 2-3. SHIPPING INFORMATION

2-4. The Model 6160B was packaged and shipped in a foam packed cardboard carton. Upon receipt, a thorough inspection should be performed to reveal any damage in transient. Special instructions for inspection and claims are included in the carton.

2-5. If reshipment is necessary, the original container should be used. If it is not available, a new container can be obtained from the John Fluke Mfg. Co., Inc. Please refer ence the Model number when requesting a new container.

## 2-6. INPUT POWER

2-7. The synthesizer can be operated from either a 115 or 230V ac, 50 to 440 Hz power line. A slide switch on the rear panel allows selection of the appropriate line voltage. The rated value of the two fuses on the rear panel are as follows:

| 115VAC | 230 VAC |
|---|---|
| 1½A SLO BLO | ¾A SLO BLO |

## 2-8. INSTALLATION

2-9. The synthesizer is designed for bench-top use or it can be installed in a standard 19 inch equipment rack with the mounting brackets shown in Figure 2-1 and 2-2. Rack mounting is done as follows:

a. Peel the decals shown in Figure 2-1 from the front corner castings.

b. Remove the screws from the front corner castings which match the hole patterns in the rack mounting brackets.

c. Attach the rack mounting brackets to the corner castings with #8-32 PHP screws.

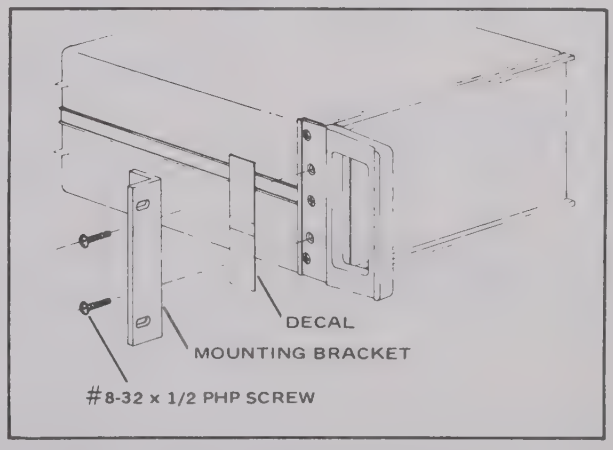



Figure 2-1. RACK MOUNTING BRACKET INSTALLATION (M07-205-600)

d. Peel the center side panel decals from the synthesizer.

e. Attach the chassis section (B) to the side panels with the screws (C) provided in the kit.

f. Install the cabinet sections (E) and center sections (D) in equipment rack. The extension angle brackets, which are part of section (E), are mounted at the rear of the cabinet.

g. Slide the center sections (D) toward the front of the cabinet until they lock in place.

h. Depress the spring locks on the chassis sections (B) and insert the synthesizer between the extended center sections (D) on the cabinet.

i. Slide the synthesizer completely into the equipment rack and secure it in place with fasteners through the rack mounting brackets.

## 2-10. OPERATING FEATURES

2-11. The location and function of all controls, connectors, and indicators is shown in Figure 2-3.

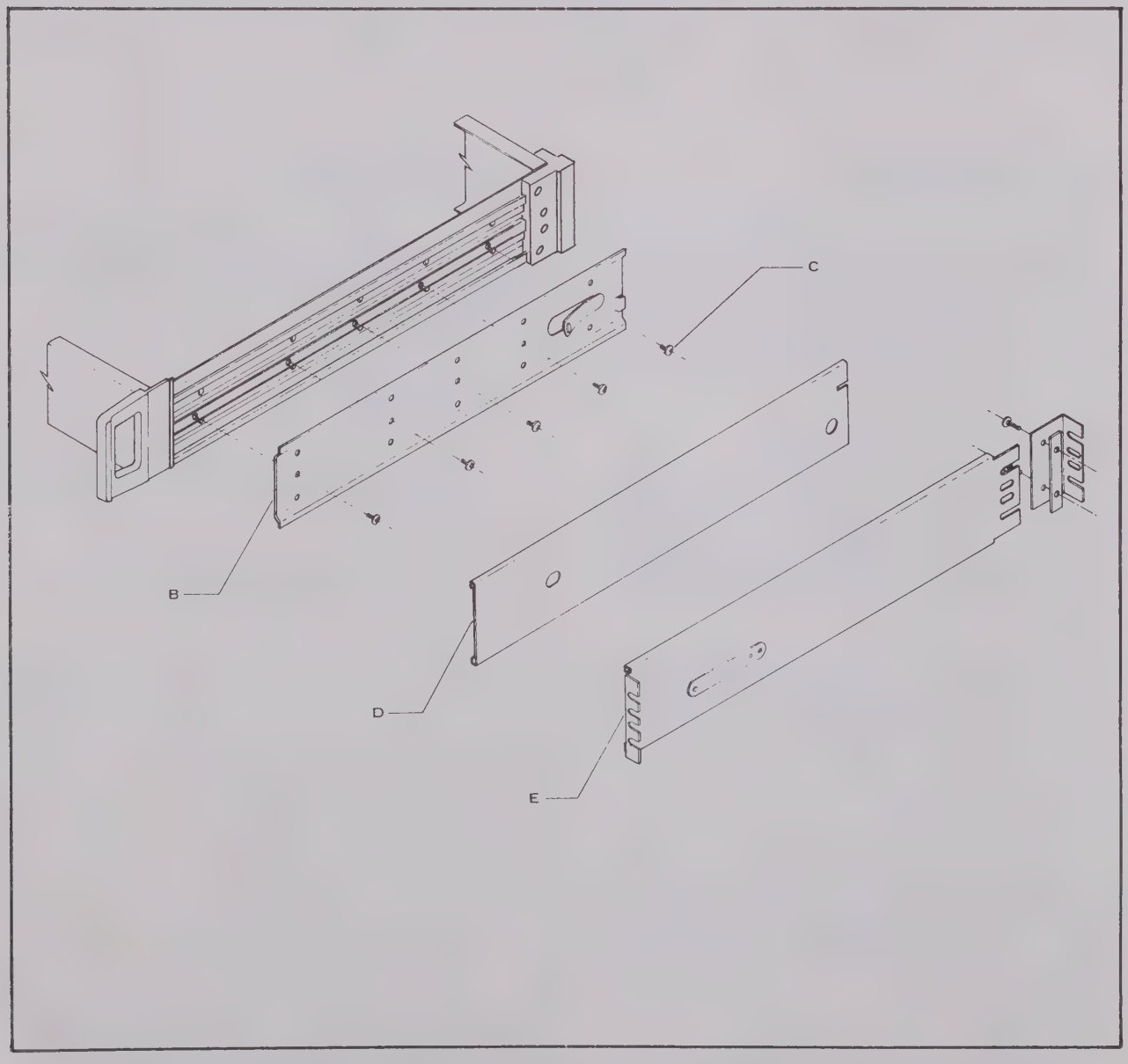



Figure 2-2. CHASSIS SLIDE INSTALLATION (MOO-280-610)

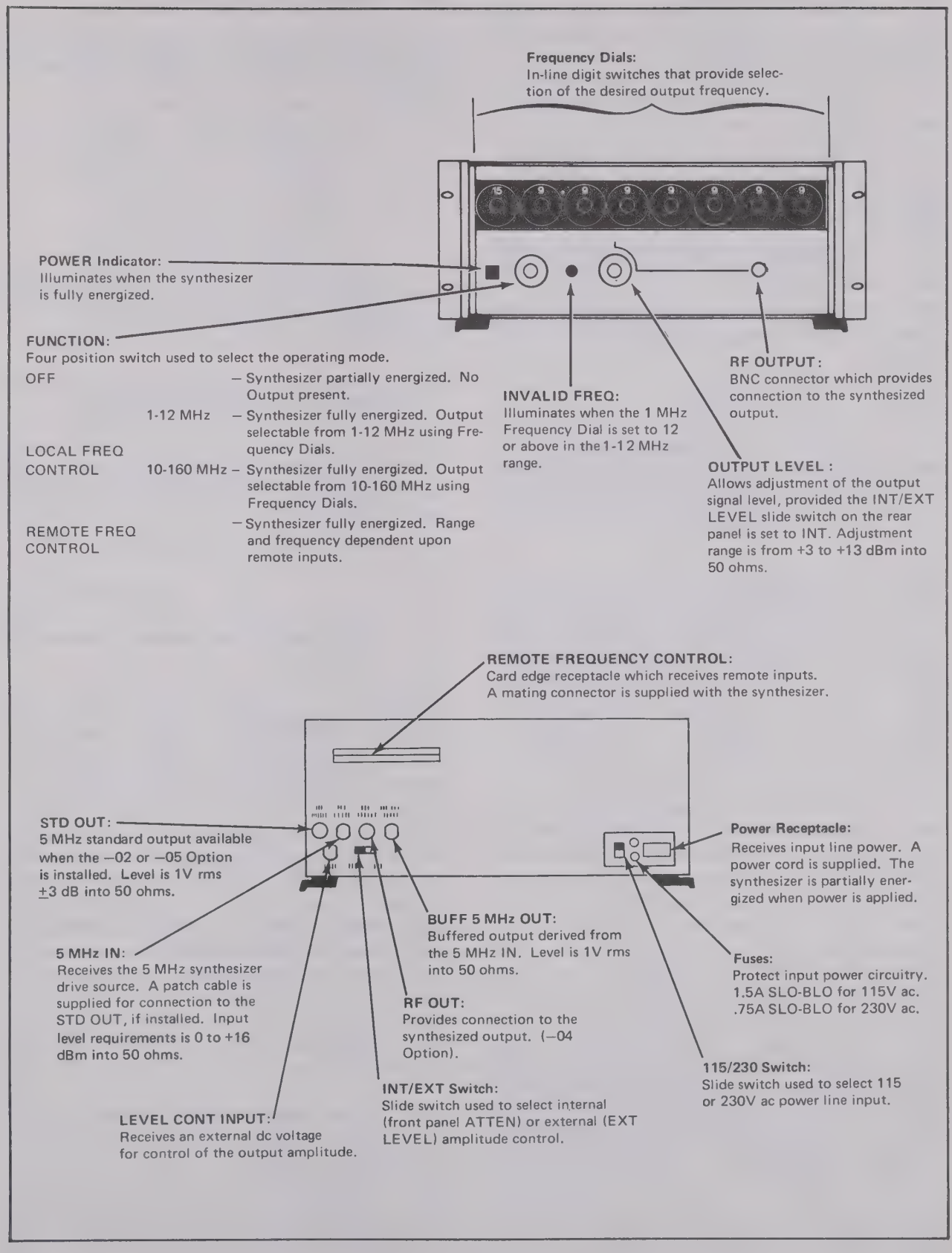

Frequency Dials:
In-line digit switches that provide selection of the desired output frequency.
POWER Indicator:
Illuminates when the synthesizer is fully energized.
FUNCTION:
Four position switch used to select the operating mode.
OFF – Synthesizer partially energized. No Output present.
LOCAL FREQ CONTROL 1-12 MHz – Synthesizer fully energized. Output selectable from 1-12 MHz using Frequency Dials.
10-160 MHz – Synthesizer fully energized. Output selectable from 10-160 MHz using Frequency Dials.
REMOTE FREQ CONTROL – Synthesizer fully energized. Range and frequency dependent upon remote inputs.
INVALID FREQ:
Illuminates when the 1 MHz Frequency Dial is set to 12 or above in the 1-12 MHz range.
RF OUTPUT:
BNC connector which provides connection to the synthesized output.
OUTPUT LEVEL:
Allows adjustment of the output signal level, provided the INT/EXT LEVEL slide switch on the rear panel is set to INT. Adjustment range is from +3 to +13 dBm into 50 ohms.
REMOTE FREQUENCY CONTROL:
Card edge receptacle which receives remote inputs. A mating connector is supplied with the synthesizer.
STD OUT:
5 MHz standard output available when the –02 or –05 Option is installed. Level is 1V rms ±3 dB into 50 ohms.
5 MHz IN:
Receives the 5 MHz synthesizer drive source. A patch cable is supplied for connection to the STD OUT, if installed. Input level requirements is 0 to +16 dBm into 50 ohms.
BUFF 5 MHz OUT:
Buffered output derived from the 5 MHz IN. Level is 1V rms into 50 ohms.
RF OUT:
Provides connection to the synthesized output. (–04 Option).
INT/EXT Switch:
Slide switch used to select internal (front panel ATTEN) or external (EXT LEVEL) amplitude control.
LEVEL CONT INPUT:
Receives an external dc voltage for control of the output amplitude.
Power Receptacle:
Receives input line power. A power cord is supplied. The synthesizer is partially energized when power is applied.
Fuses:
Protect input power circuitry. 1.5A SLO-BLO for 115V ac. .75A SLO-BLO for 230V ac.
115/230 Switch:
Slide switch used to select 115 or 230V ac power line input.

Figure 2-3. OPERATING FEATURES

## 2-12. OPERATING NOTES

### 2-13. AC Line Connection

2-14. The input power cord has a three prong, polarized plug. This plug allows connection to either a 115 or 230V ac, 50 to 500 Hz, single phase power line. The round pin on the plug connects the chassis to earth ground, therefore ensure that it is connected to a high quality earth ground.

2-15. The synthesizer is partially energized when the power cord is connected to line power. This is done to provide continuous operating voltages for the oven of the Internal Frequency Standard (–02 Option) should it be installed.

*NOTE!*

*Line power must be applied for at least 72 hours before the specified frequency stability of the –02 Option Internal Frequency Standard is obtained.*

### 2-16. Drive Source

2-17. A 5 MHz reference signal is required as a drive source. Input signal level requirements is 1V rms ±3 dB into 50 ohms. This signal is applied to the 5 MHz INPUT connector on the rear panel. A buffered 5 MHz signal derived from the drive source is available at the BUFF 5 MHz OUTPUT connector.

2-18. When the –02, or –05 Option is installed, a reference drive signal is available at the STD OUTPUT connector. A patch cable is included for connection to the 5 MHz INPUT connector. If an external drive signal is used, care should be exercised in transmitting the signal to the synthesizer to avoid contamination by hum and noise.

### 2-19. External Amplitude Control

2-20. Provisions have been made to allow the use of an external dc voltage to control the output signal level of the synthesizer. A LEVEL CONT INPUT connector on the rear panel receives the dc voltage. Selection of this feature is through an INT/EXT slide switch also located on the rear panel. Range of the external amplitude control is +3 to +13 dBm. The dc control voltage level is approximately equal to rms level of the rf output. Input resistance at the INPUT connector is > 2 kilohm.

## 2-21. OPERATIONAL TESTS

2-22. The following tests can be used to initially verify operation of the synthesizer. Required test equipment is as follows:

1. Frequency Counter — Fluke 1952A-07-09
2. RF Voltmeter — HP411A
3. BNC "T"
4. 50 ohm in-line compensated load
5. 50 ohm coax cable

a. Set the 115/230 slide switch to appropriate power line voltage. Refer to paragraph 2-6 for fuse ratings.

b. Connect power cord to line power. Refer to paragraph 2-13 grounding information.

c. Apply 5 MHz drive signal to 5 MHz INPUT connector. Refer to paragraph 2-15 for input requirements.

d. Set INT/EXT slide switch to INT.

e. Set the FUNCTION switch to 1 – 12 MHz. POWER indicator on the front panel should be illuminated.

f. Set Frequency Dials to 1.0000000.

g. Set OUTPUT LEVEL to +3 dBm position.

h. Connect rf voltmeter through 50 ohm in-line load to RF OUTPUT connector.

i. Rotate OUTPUT LEVEL control throughout its range, observing that output signal level is adjustable from +3 to +13 dBm.

j. Set OUTPUT LEVEL control to provide a +13 dBm output.

k. Rotate Frequency Dials throughout frequency range, observing output level is +13 dBm ±1 dB.

l. Set FUNCTION switch to 10 – 160 MHz, observing decimal lamp shifts one decade to the right, and repeat step f.

m. Disconnect rf voltmeter.

n. Connect frequency counter through 50 ohm coax cable to RF OUTPUT connector. Switch in 50 ohm internal load of counter, if available. If counter is not equipped with internal 50 ohm load, connect an external 50 ohm load to counter input connector.

o. Gate counter externally with signal derived from synthesizer frequency standard.

p. Rotate each Frequency Dial throughout its range, observing that a corresponding output frequency is present.

q. Set FUNCTION switch to 1 – 12 MHz and repeat step p.

2-23. If the preceding test conditions were obtained, the synthesizer can be considered fully operational. The test equipment can be disconnected and the synthesized output used as desired.

## 2-24. OPERATION

### 2-25. Frequency Selection

2-26. Selection of the desired output frequency is done from the front panel or remotely with programming inputs to the REMOTE FREQUENCY CONTROL connector on the rear panel. A FUNCTION selector on the front panel selects manual or remote mode of operation. Manual operation is in effect when the 1 - 12 MHz or 10 - 160 MHz position is selected. The desired frequency is then selected and indicated using the Frequency Dials. Maximum output frequency is 11.999999 MHz in the 1 - 12 MHz range and 159.999999 MHz in the 10 - 160 MHz range. If the most significant decade is dialed to 12 or above in the 1 - 12 MHz range, an incorrect output will be indicated by the INVALID FREQ indicator on the front panel. Remote operation is in effect when the FUNCTION selector is set for REMOTE FREQ CONTROL. Remote operation is described in paragraph 2-31.

### 2-27. Amplitude Control

2-28. The output signal amplitude is adjustable from +3 dBm to +13 dBm into 50 ohms using a front panel OUTPUT LEVEL control or a dc control voltage applied to the LEVEL CONT INPUT connector on the rear panel. An INT/EXT slide switch on the rear panel selects the desired control feature. The OUTPUT LEVEL control on the front panel is in effect when the slide switch is set to INT. The external dc control voltage is selected when the slide switch is set to EXT. Input requirements for the external dc control voltage are described in paragraph 2-19.

### 2-29. Fixed Output

2-30. A fixed 5 MHz output signal is available at the BUFF 5 MHz OUTPUT connector on the rear panel. This signal is derived from the reference drive source input. The level is preset to nominally 1V rms into 50 ohms.

### 2-31. Remote Control

2-32. Control of the output frequency and range is possible through a REMOTE FREQUENCY CONTROL connector on the rear panel. Interface between the programming equipment and the synthesizer is provided through an Amphenol (261-10022-201-50001) mating connector supplied with the synthesizer. Figure 2-4 lists and describes each terminal of the connector.

2-33. Programming input requirements are compatible with DTL or TTL logic using BCD coding. Logic "0" is 0 to +0.9V dc or logic ground. Logic "1" is +2 to +5V dc. Logic ground is available at terminals 6, 7, and 8 of the connector.

*NOTE!*

*Logic levels are defined without specifying a maximum digital noise factor of 0.5V. If noise is to be considered, then Logic "0" should be 0 to +0.5V dc or logic ground, and Logic "1" should be +2.5V to +5V dc.*

2-34. Remote control is activated by placing the FUNCTION selector on the front panel to REMOTE FREQ CONTROL position. Presence of a Logic "0" at terminal 5 of the rear panel connector selects the 1 – 12 MHz range. A Logic "1" at this terminal selects the 10 – 160 MHz range. BCD inputs at terminals 10 and 13 through 44 control selection of the output frequency. All decades can be programmed to a maximum of 9 (8 + 1). Inputs above 9 will cause an invalid output.

| TERMINAL | FUNCTION |
|---|---|
| 1 | POWER FLAG: LOGIC "0" = POWER OFF; LOGIC "1" = POWER ON |
| 2 | SPARE |
| 3, 4 | KEY |
| 5 | RANGE: LOGIC "0" = 1-12 MHz; LOGIC "1" = 10-160 MHz |
| 6, 7, 8 | LOGIC GND |
| 9 | SPARE |
| 11 | REMOTE FLAG: LOGIC "0" MANUAL; LOGIC "1" = REMOTE |
| 12 | SPARE |
| | BIT — DECADE (RANGE) |
| 10 | 1 — 100 MHz (10-160 MHz); 10 MHz (1-12 MHz) |
| 14, 13, 16, 15 | 1, 2, 4, 8 — 1 MHz (1-12 MHz); 10 MHz (10-160 MHz) |
| 18, 17, 20, 19 | 1, 2, 4, 8 — 100 kHz (1-12 MHz); 1 MHz (10-160 MHz) |
| 22, 21, 24, 23 | 1, 2, 4, 8 — 10 kHz (1-12 MHz); 100 kHz (10-160 MHz) |
| 26, 25, 28, 27 | 1, 2, 4, 8 — 1 kHz (1-12 MHz); 10 kHz (10-160 MHz) |
| 30, 29, 32, 31 | 1, 2, 4, 8 — 100 Hz (1-12 MHz); 1 kHz (10-160 MHz) |
| 34, 33, 36, 35 | 1, 2, 4, 8 — 10 Hz (1-12 MHz); 100 Hz (10-160 MHz) |
| 38, 37, 40, 39 | 1, 2, 4, 8 — 1 Hz (1-12 MHz); 10 Hz (10-160 MHz) |
| 42, 41, 44, 43 | 1, 2, 4, 8 — 0.1 Hz (1-11 MHz); 1 Hz (10-160 MHz) |

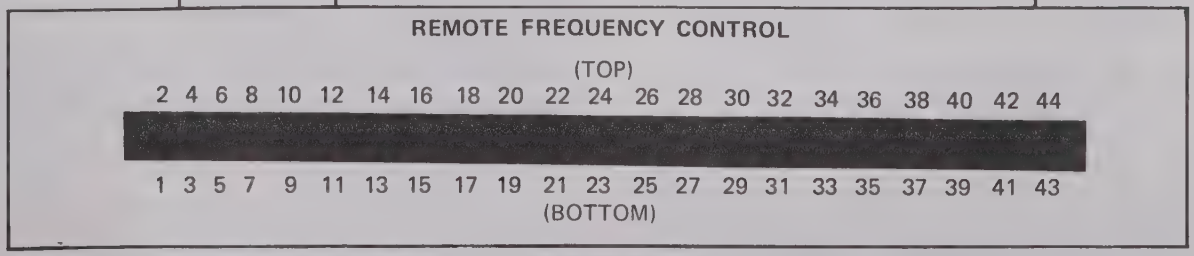



Figure 2-4. REMOTE FREQUENCY CONTROL CONNECTOR TERMINALS

# Section 3
# Theory of Operation

## 3-1. INTRODUCTION

3-2. This section contains the theory of operation for the Model 6160B Frequency Synthesizer. The theory description is presented first in a simplified block diagram description then a functional block diagram description, followed by circuit descriptions. A complete set of schematic diagrams is contained at the rear of the manual.

3-3. The 6160B Frequency Synthesizer generates discrete frequencies from 1 MHz to 160 MHz (159.999999 MHz) in two ranges. One range is from 1 to 12 MHz and provides 0.1 Hz resolution. The other range is from 10 Hz to 160 MHz with 1 Hz resolution.

3-4. The synthesis technique used is the indirect method. This method employs voltage controlled oscillators (VCO) and phase detectors in phase locked loop arrangements which are referenced to a frequency standard. The arrangement insures accurate and stable output frequencies with low spurious signals and very low phase noise.

## 3-5. SIMPLIFIED BLOCK DIAGRAM DESCRIPTION

3-6. A simplified block diagram of the 6160B is illustrated in Figure 3-1. As shown in the diagram, the 6160B can be divided into five basic blocks; Computer, Digit Generator, Output Divider, Frequency Standard, and Input Filter. The synthesis process occurs within the Digit Generator and Output Divider. Front Panel or Remote control BCD commands are processed by the Computer and applied to the Digit Generator. These BCD digit commands direct the Digit Generator to produce discrete frequencies corresponding to each frequency dial selected on the front panel. These frequencies are combined to provide a coherent output from 80 to 160 MHz. The 80 to 160 MHz signal is applied to the Output Divider. Under commands by the Computer, the Output Divider divides the input frequency by 1, 2, 4, 8, 10, 20, 40, or 80 to yield the frequency selected on the front panel frequency dials (or remote control). Stability and accuracy of the output signal is based on the Frequency Standard. The standard may come from an external 5MHz source or from one of the internal crystal oscillator options (6160B–02, or –05). The 5 MHz signals from the Frequency Standard is applied to the Input Filter where it is buffered and processed to provide a TTL level square wave output. This TTL output is applied to the Digit Generator as a reference for producing discrete frequencies.

## 3-7. FUNCTIONAL BLOCK DIAGRAM DESCRIPTION

3-8. The following paragraphs describe operation of the synthesizer using the 6160B Block Diagram, Drawing No. 6160B-1501, located at the rear of the manual. Supplemental block diagrams will be used during this description. These drawings are given figure numbers and occur in the following text.

### 3-9. Frequency Standard

3-10. The master oscillator for the frequency synthesizer can be either an external or internal 5 MHz standard. The internal standard is available in two options. One of these self-contained 5 MHz crystal oscillators is available as the –02 Option with 2 X $10^{-9}$ per day drift rate. The

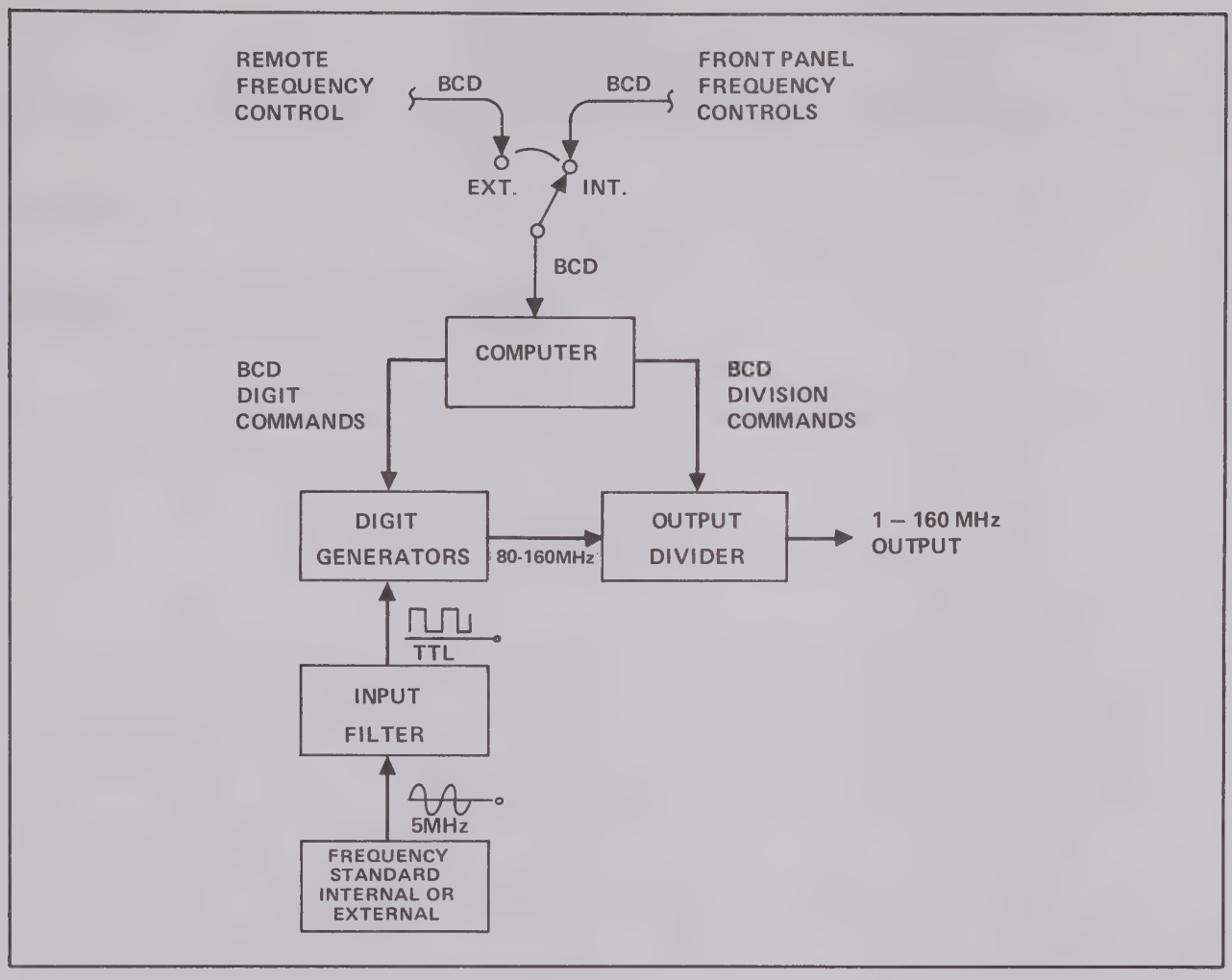



Figure 3-1. 6160B SIMPLIFIED BLOCK DIAGRAM

–02 option utilizes an oven for temperature control. The –05 option is a temperature compensated crystal oscillator (TCXO) with 5 X $10^{-6}$ per drift rate.

## 3-11. Input Filter

3-12. The Input Filter conditions and distributes the 5 MHz Frequency Standard signal. This signal is buffered, filtered, and amplified to provide two 5 MHz signals. It also incorporates a X2 multiplier to provide a 10 MHz signal. One of the 5 MHz signals is preset to a level of 1 Vrms into 50 ohms and made available at the BUFF 5MHz OUT connector on the rear panel. The other 5 MHz signal is distributed to the 1 MHz Digit Unit (D.U.) Step Loop, (6160B-4153-1) for a reference. The 10 MHz signal is applied as a reference to the 10 MHz D. U. Step Loop Phase Detector (6160A-4106-1).

3-13. The 5 MHz signal to the 1 MHz Digit Unit Step Loop module is divided to 1 MHz by a 5/1 divider. This signal functions as a reference for the 1 MHz D. U. Step Loop. It is also applied to the Six Digit Generator (6040A-4102) where it buffered and applied to the Computer as a clock signal. The 1 MHz reference undergoes further division for use within Six Digit Generator.

## 3-14. Computer

3-15. The frequency control Computer (6160B-4012) generates internal frequency control commands from manual or remote synthesizer frequency control inputs. Manual inputs are from the front panel frequency controls. Remote inputs are from the REMOTE FREQUENCY CONTROL connector on the rear panel. These inputs are multiplexed serial by decade, processed, and then converted to parallel digital commands that establish correct synthe-

sis conditions necessary to obtain the preselected output. A simplified diagram of the Computer is shown in Figure 3-2. A formula given in this illustration can be used to determine what digital output commands are generated for any preselected input.

3-16. Input commands from the front panel or rear panel are applied to the multiplexers. The band logic decodes input to 10 MHz digit information and selects the appropriate x1, x2, x4, or x8 gates. Range commands are applied with the band commands to the Output Divider to select dividers and gates in that module.

3-17. A 1 MHz clock input controls the parallel to conversion process. This input signal is applied to the load generator and divided by two to drive the address generator. The address generator produces binary address data to the multiplexer and address converter. The multiplexers serially transfer the parallel synthesizer frequency control BCD inputs in 1 Hz to 10 MHz decade order to the first x2 multiplier and the x1 gates. The output of the first x2 multiplier is applied to the following x2 multiplier as well as the x2 gates. The output of the second x2 multiplier is applied to the x4 gates as well as the final x2 multiplier, which produces the x8 output. Carry outputs are sequentially applied to the following multiplier by the carry "A" and "B" storage circuits. Carry load commands are derived from the load generator. The multiplied and gated serial by decade BCD information is then applied to the 1 MHz and 10 MHz storage circuits and x2 Multiplier. Conversion of the serial information to parallel format is done in the storage circuits. These circuits are addressed in sequence with each decade transfer period by control commands from the address converter.

## 3-18. Digit Generator

3-19. Figure 3-3 illustrates the composition of the Digit Generator discussed in the Simplified Block Diagram description. Frequencies for the six lower order decades, 1 Hz through 100 kHz, are produced in the Six Digit Generator. Frequencies for the 1 MHz and 10 MHz decades are produced in the 1 MHz and 10 MHz Digit Generators, respectively. The same basic circuit arrangement is used in each generator and will be described in the following paragraph. Afterwards, each of the generators will be described separately.

3-20. Figure 3-4 illustrates the basic phase lock loop circuit arrangement used for each decade in the generators.

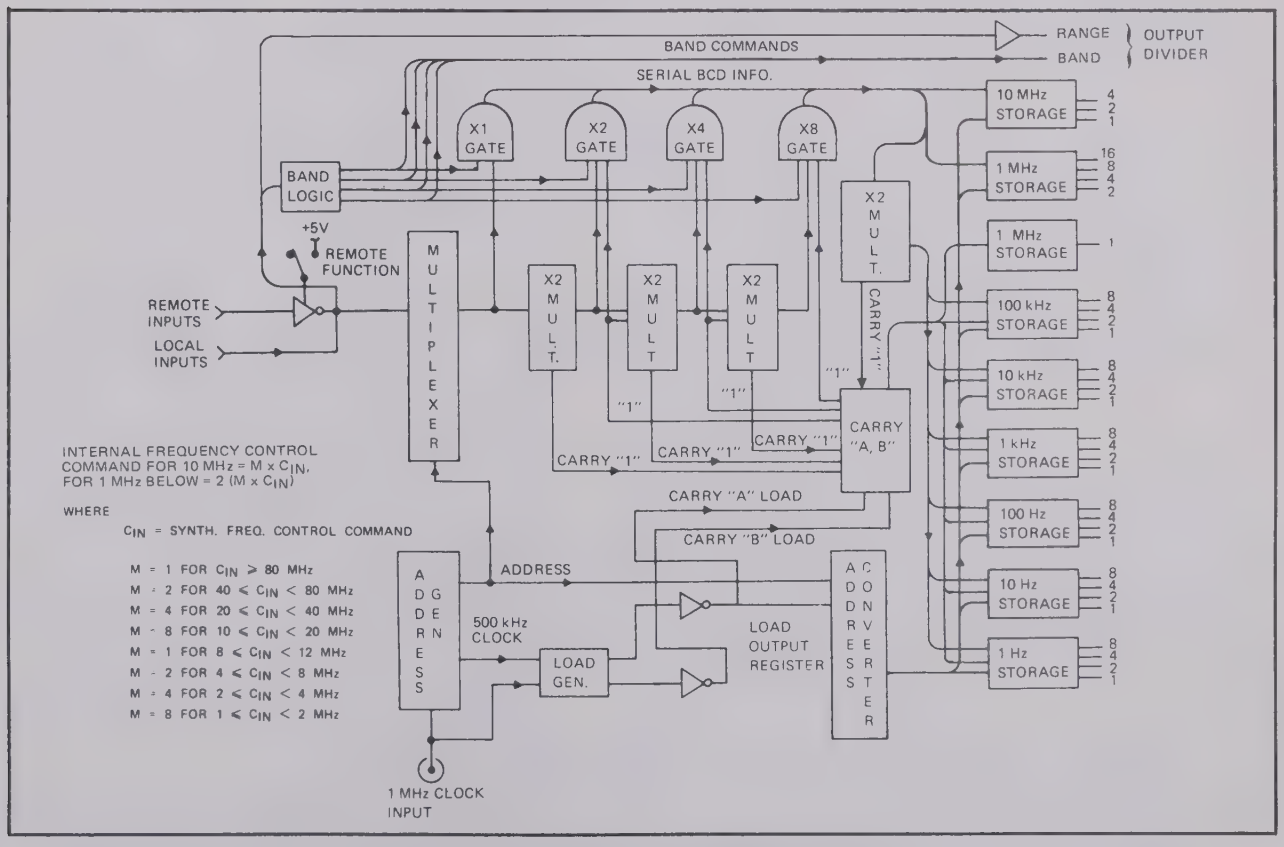



Figure 3-2. FREQUENCY CONTROL COMPUTER

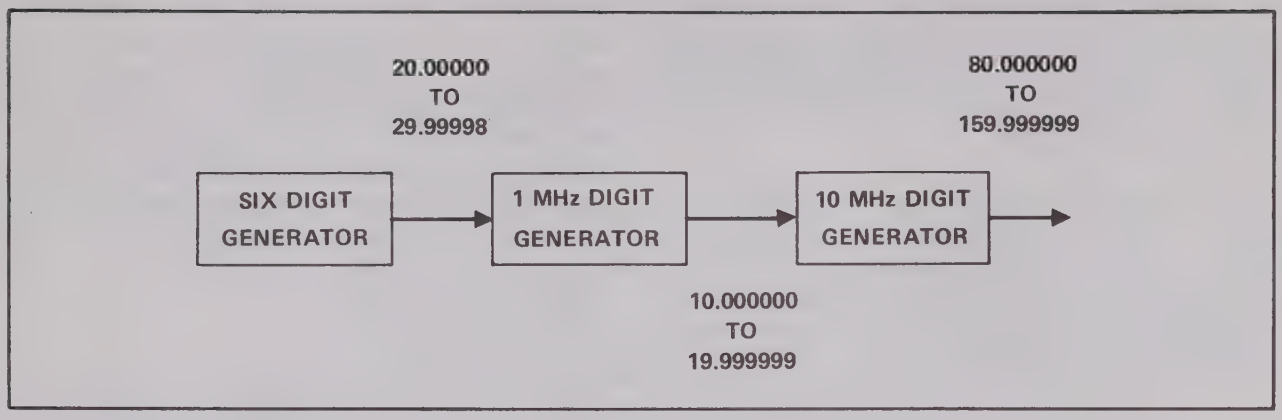



Figure 3-3. DIGIT GENERATORS

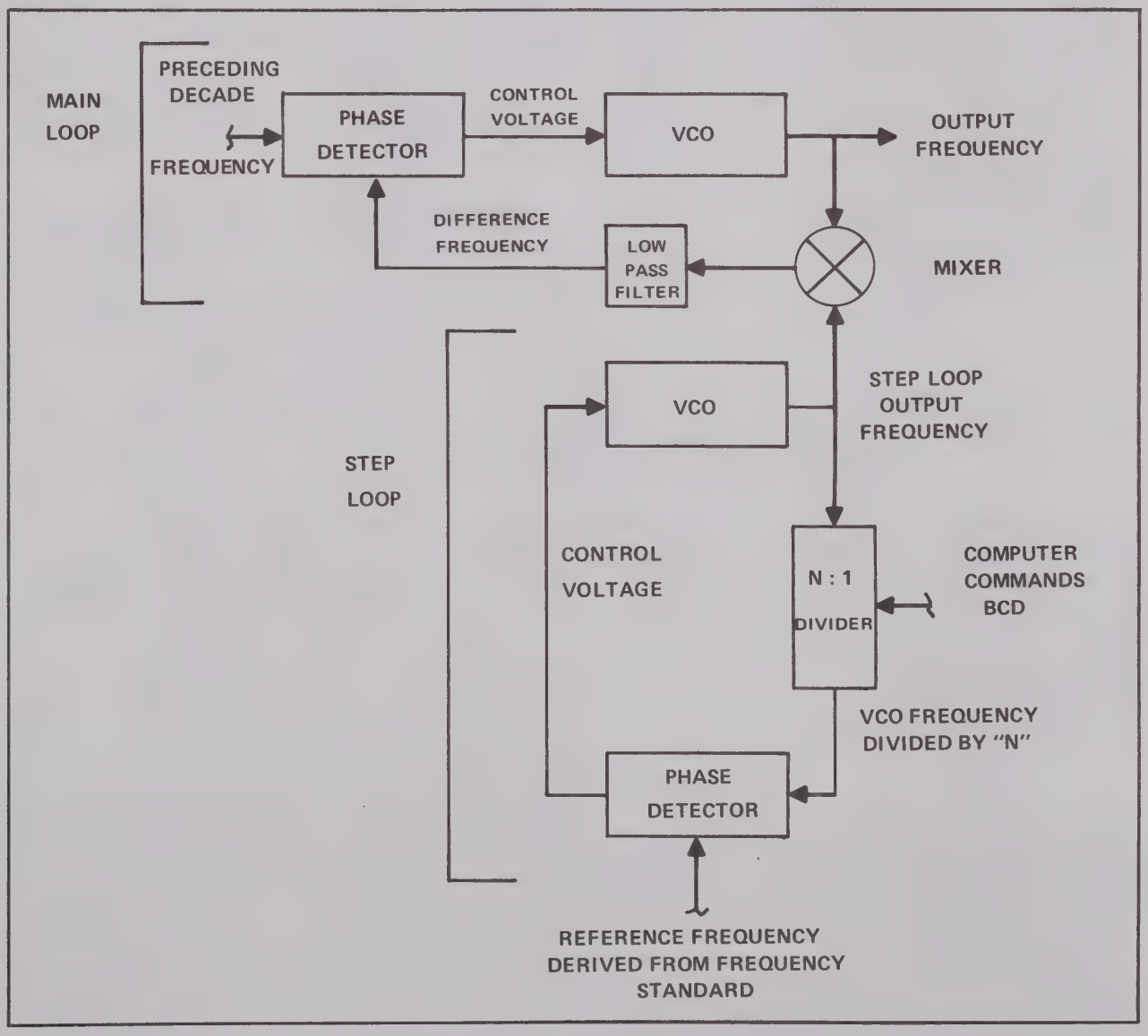



Figure 3-4. PHASE LOCK LOOP ARRANGEMENT

The arrangement consists of Main Loop and Step Loop circuitry. Discrete frequency steps for each digit selected in a decade are produced in the Step Loop. These steps are then added to the preceeding decade frequency in the Main Loop circuit.

3-21. Beginning with the Step Loop, a reference frequency derived from the synthesizer's frequency standard is applied to one input of the phase detector. A divided down Step Loop VCO frequency is applied to the other input. Any difference between the two frequencies results in a dc control voltage output from the Phase Detector. This control voltage is applied to the Step Loop VCO and changes the output frequency until the inputs to the Phase Detector are equal, resulting in a phase lock condition. The Step Loop VCO output frequency is applied to one input of the Main Loop Mixer where it is mixed with the Main Loop VCO frequency. The Mixer output is applied to the Low Pass Filter which yields the difference frequency. A control voltage from the Main Loop Phase Detector changes the VCO frequency until the difference frequency equals the preceeding decade frequency. This results in a Main Loop VCO output frequency which is equal to the Step Loop VCO frequency plus the preceeding decade frequency.

3-22. Varying the frequency steps in a decade is accomplished by varying the division ratio of the N:1 Divider. The N:1 Divider is a programmable counter. It can be preset by BCD commands from the Computer. How much the Step Loop VCO frequency is divided depends upon how many counts are required from any given preset count to the end of the count cycle.

3-23. SIX DIGIT GENERATOR (6040A-4102). Refer to the Block Diagram (drawing 6160B-1501) at the rear of the manual. The Six Digit Generator contains three loops that handle two decades of frequency control. The first loop, which is basically a step loop, controls the 1 Hz and 10 Hz decades. Here, the N:1 Divider has division ratios from 1100 to 1001. With zeros applied from the Computer to the 1 Hz and 10 Hz BCD control lines of the divider, a division ratio of 1100:1 is achieved. Consequently, with nines applied the ratio is 1001. To determine the frequency of the VCO, multiply the known division ratio by the reference frequency. For example, if zeros are applied, the ratio is 1100 which when multiplied by the 25 kHz reference equals 27.5 MHz.

3-24. In the 100 Hz and 1 kHz loop, the frequency steps are generated by a Step Loop and added to the preceeding 1 Hz and 10 Hz frequency in the Main Loop. The N:1 Divider ratio is from 489, for zeros, and 390, for nines. The 10 kHz and 100 kHz circuit is similar in construction but with an N:1 Divider ratio of 205 to 309:1. This time with zeros programmed, the division is 205:1 and with nines programmed, 304:1.

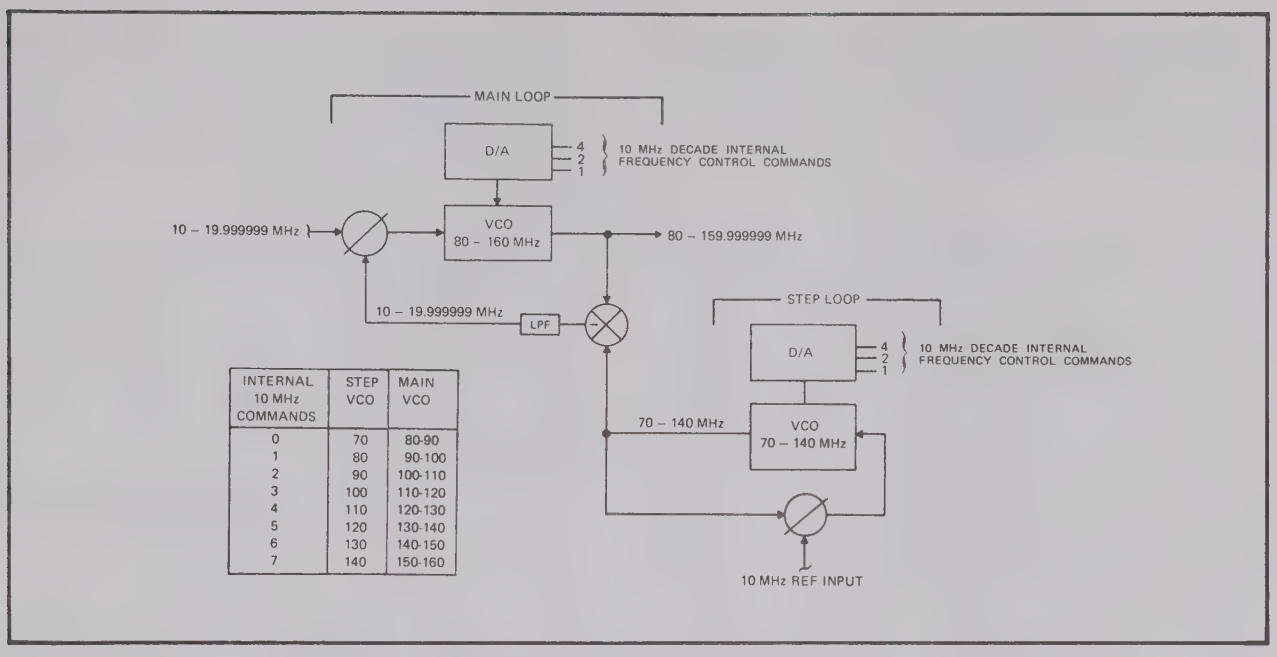
3-25. 1 MHZ DIGIT GENERATOR (6160B-4153). Since the 1 MHz Digit Generator must add its frequency steps to the preceeding Six Digit Generator, it contains a Main Loop and Step Loop. The loops, however, are divided into three modules. The Step Loop is the 6160B-4153-1, Main Loop VCO is 6160B-4153-2, and the Main Loop Phase Detector is 6160B-4153-3. A 1 MHz reference frequency is used in the Step Loop which has a VCO range from 18-37 MHz. Consequently, the N:1 Divider has division ratios of 18-37:1 in 20 steps. With the divider programmed for zero, the ratio is 18:1.

3-26. 10 MHz DIGIT SECTION. The 10 MHz Digit Section consists of five separate modules which together form the step and main loops shown in Figure 3-5. The output ranges from 80 to 159.999999 MHz. The step loop consists of modules titled 10 MHz Step Loop Phase Detector (6160A-4106–1) and 10 MHz D.U. Step Loop VCO (6160A-4107–1). The main loop consists of the 10 MHz D. U. IF Mixer (6160A-4108), 10 MHz D. U. Phase Detector (6160A-4109), and 10 MHz D. U. Main VCO (6160A-4110).

3-27. The 10 MHz step loop modules produce a 70 to 140 MHz output in 10 MHz increments (see table in Figure 3-4). The circuitry associated with the 10 MHz step loop consists of a D/A converter, VCO, and a phase detector. The D/A converter receives the 10 MHz decade internal frequency control commands and produces a dc control voltage which presteers the VCO near to the desired frequency. The resulting VCO signal is then phase locked to a 10 MHz reference using a phase detector.

3-28. The 10 MHz main loop combines the 10 MHz step loop signal and the previous decade information to produce an 80 to 159.999999 MHz output. This signal is produced using a D/A converter and VCO in the 10 MHz D. U. Main VCO module, a subtractive mixer and LPF in the 10 MHz D. U. IF Mixer module, and a phase detector in the 10 MHz D. U. Phase Detector module.

3-29. The D/A converter receives the 10 MHz decade internal frequency control commands and produces a dc control voltage which presteers the VCO to nearly the desired frequency. Nominal overall range of the VCO is from 80 to 160 MHz in 10 MHz range increments. The VCO output is applied to a subtractive mixer and the Output Divider




| INTERNAL 10 MHz COMMANDS | STEP VCO | MAIN VCO |
|---|---|---|
| 0 | 70 | 80-90 |
| 1 | 80 | 90-100 |
| 2 | 90 | 100-110 |
| 3 | 100 | 110-120 |
| 4 | 110 | 120-130 |
| 5 | 120 | 130-140 |
| 6 | 130 | 140-150 |
| 7 | 140 | 150-160 |

Figure 3-5. 10 MHz DIGIT SECTION

module. The 10 MHz step loop signal of 70 to 140 MHz functions as the other input to the subtractive mixer. Since the main loop signal is 10 to 20 MHz above the step loop signal, the output of the mixer will be approximately 10 - 20 MHz. The resulting output of the mixer is filtered in the LPF and applied to the phase detector. The phase detector compares the mixer output to the output of the 1 MHz Digit Unit Section and supplies a dc control voltage to the main loop VCO that phase locks the main loop such that both inputs to the phase detector are equal in frequency. The resulting 80 to 159.999999 MHz output from the VCO thus contains the entire digit information.

3-30. OUTPUT DIVIDER. The Output Divider (6160A-4111) receives the synthesized frequency of 80 to 159.999999 MHz and produces the final 1 to 159.999999 MHz output. The circuitry consists of an input buffer, six 2/1 dividers, a 5/1 divider, low-pass filters, gates and an output amplifier.

3-31. The 80 to 159.999999 MHz signal is amplified in the input buffer and applied to a gate, low-pass filter, and a 2/1 divider. The 2/1 divider and each successive divider then provides divided down signals to associated low-pass filters. Activation of the appropriate gate by the range and band commands from the frequency control computer then applies the desired low-pass filter output to the output amplifier. This synthesized signal corresponds to the preselected output. For example, if a 13.111111 MHz output is selected, the 10 - 160 MHz range and 10 - 20 MHz band commands activates the gates for the 20 MHz low-pass filter. Since the synthesized input to the Output Divider would be 104.888888 MHz, it is divided by three 2/1 dividers to obtain the preselected 13.111111 MHz output. The output amplifier then produces a +3 to +13 dbm output signal dependent upon the position of the OUTPUT LEVEL control or an external dc amplitude control voltage.

3-32. POWER SUPPLY. The Power Supply (6160A-4014) produces dc operating voltages of +5, +14, and −12V. It receives ac power through the Mother Board (6160A-4013) from the Power Transformer (6160A-4116). A dual winding in the primary of the power transformer allows operation from either a 115 or 230V ac line. The three operating voltages are regulated by individual series-pass regulators. The series-pass transistors are mounted on the Heat Sink (6160A-4021) located on the rear panel.

## 3-33. CIRCUIT DESCRIPTIONS

3-34. The following paragraphs describe in detail the circuitry in the synthesizer. Associated schematic diagrams are located at the rear of the manual.

### 3-35. Front Panel PCB Assembly (6160A-4051)

3-36. The Front Panel PCB assembly (Drawing No. 6160A-1051) provides a means to energize the synthesizer as well as converting manual frequency commands to BCD information that are processed by the Computer Assembly

(6160B-4012). It also provides visual indication of operating conditions through light emitting diodes (LED's) labeled POWER and INVALID FREQ. Frequency Dials provide in-line decimal indication of the manually selected frequency. A FUNCTION switch allows selection of two frequency ranges (1 - 12 MHz and 10 - 160 MHz) and the remote mode of operation. Decimal indicators (LED's) are illuminated in the appropriate range such that the manually selected frequency is displayed in MHz. An OUTPUT LEVEL controls allows setting of the RF OUTPUT level anywhere between +3 and +13 dbm.

3-37. Energizing of the synthesizer is done using the FUNCTION switch S9. When S9 is set to a position other than OFF, a ground, via S9C, is applied to terminals 14 and 21 of J1. These grounds enable the Power Supply (Drawing No. 6160A-1014) via the Computer and Mother Board (Drawing Nos. 6160A-1012 and 1013), which then produces +5V, +14V, and −12V operating voltages. Presence of the +5V operating voltage at terminals 32 and 34 of J2 illuminates POWER indicator CR4 via R10. This +5V also illuminates decimal indicator CR1 or CR2 via S9A when it is set to the corresponding 10 - 160 MHz or 1 - 12 MHz position. When the FUNCTION switch is set to OFF, a ground is made available, via S9C, to terminal 13 of J1 which enables the internal Frequency Standard (−01 or −02 Option).

3-38. Selection of the 1 - 12 MHz or 10 - 160 MHz range provides a ground, via S9B, to the rotors of Frequency Dials S1 through S8. These switches produce BCD commands (0V = true) to J1 and J2 which are processed by the Computer assembly to establish the manually selected output frequency. Diodes CR2 through CR33 provide isolation when the REMOTE mode is selected. Selection of the REMOTE mode opens the ground to the rotors of S1 through S8, via S9B, and also opens the ground to terminal 21 of J2. Subsequently, the Frequency Dials are disabled in the REMOTE mode. Absence of the ground at terminal 21 of J2 and presence of +5V at terminals 31 and 33, via S9A, then causes the Computer assembly to process only inputs from the remote input connector at the rear panel.

3-39. The INVALID FREQ. indicator CR3 is illuminated whenever the 1 - 12 MHz range is selected and the 10 MHz Frequency Dial is set to 12 and above. NOR gate U1 receives the 8 and 4 bit commands from S8 at its pins 1 and 2 and ground via S9B when the 1 - 12 MHz range is selected. Presence of all three grounds produces a 0V output at pins 6 and 8 of U1. This 0V output provides a return to ground for CR3 via R1 and R2 and illuminates the INVALID FREQ indicator.

3-40. Control of the output signal level is done using the RF LEVEL control R7. Variable resistor R7 together with R3, R4, R6, and R8 form a divider between ground and +5V. The wiper voltage of R7 is made available to P1 and the Output Divider module (6160A-4111) via an INT/EXT slide switch on the rear panel. Variable resistors R4 and R6 allow adjustment of the upper and lower voltage limits of R7.

## 3-41. Power Supply (6160A-4014)

3-42. The Power Supply (Drawing No. 6160A-1014) consists of three low-ripple supplies which provide operating voltages of +5V, +14V, and −12V for the synthesizer. A block diagram of the circuitry is shown in Figure 3-6.

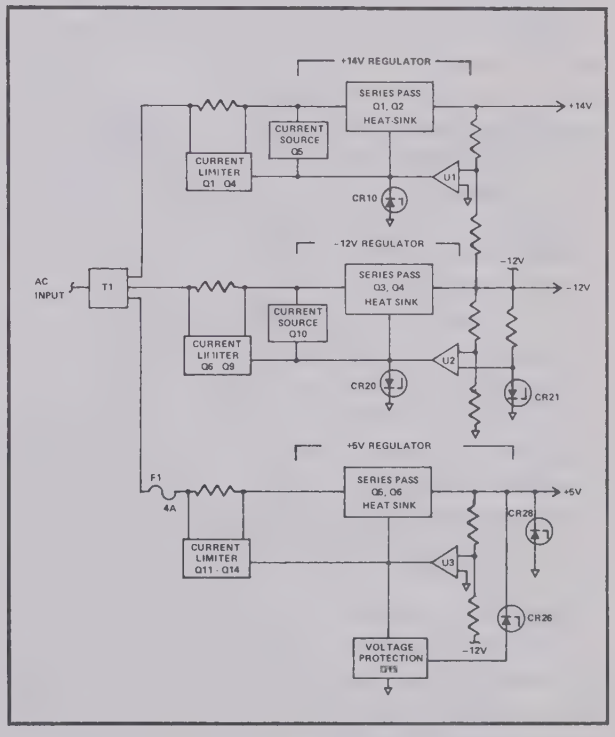



Figure 3-6. POWER SUPPLY BLOCK DIAGRAM

3-43. Input power transformer T1 receives ac line power through the RFI filter, fuses F1 and F2, and slide switch S1. The primary windings of T1 are connected in parallel via S1 for 115V line operation or in series for 230V line operation. Three separate secondary windings of T1 supply full-wave rectifiers CR1 through CR6 and C1 through C3 with required ac operating voltages. The resulting rectified dc voltages are applied to P1 and P2 of the power supply. The dc voltage at pin L of P1 (+24V) is applied to the +14V regulator. It also functions as an unregulated supply voltage for the optional Frequency Standard (6160A-4018). The

dc voltage at pin 4 of P2 (−24V) is applied to the −12V regulator. The dc voltage at pins 9 and 10 of P2 (+10V) is applied to the +5V regulator.

3-44. The +14V supply consisting of Q1 through Q5, U1, and series pass elements mounted on the heat sink produces a low-ripple +14V dc operating voltage for the synthesizer. It also contains a current limiter which prevents overloads from harming the supply. The regulator is enabled by a ground applied to R8 via the FUNCTION switch on the front panel. It consists of constant current source Q5, comparator amplifier U1, and series pass elements Q1 and Q2. Constant current source Q5 provides operating current for the series pass elements Q1 and Q2 and the comparator amplifier U1. One input to U1 is referenced to supply common via R15. The other input to U1 is derived from divider R17 through R21 connected between the +14V and −12V outputs. Subsequently, the +14V regulator is referenced to the −12V regulator. Any variations in the +14V output are sensed at the junction of R18 and R19 by U1, amplified, and alter the conduction of the series pass transistors Q1 and Q2 to maintain the +14V output. Variable resistor R21 allows adjustment of the +14V output. Drive voltage input to Q2 is prevented from exceeding +18V by CR10 in the event U1 and associated circuitry fails.

3-45. Current overloads are prevented from harming the +14V regulator by Q1 through Q4. Transistor Q1 together with temperature compensator Q2 monitor the voltage drop across R4. When the current through R1 exceeds approximately 1.2A, current through Q1 and resistors R1, R2 in its collector produces a turn-on voltage for Q4. Conduction of Q4 prevents any further increase in base current for series pass driver Q2. The resulting current via series pass element Q1 is subsequently limited at 1.2A. If the regulator output falls below +14V during a current limit condition, transistor Q3 conducts and further decreases drive current to series pass driver Q2, thus providing "fold-back" current limiting of the regulator output. An example of "fold-back" limiting is shown in Figure 3-7.

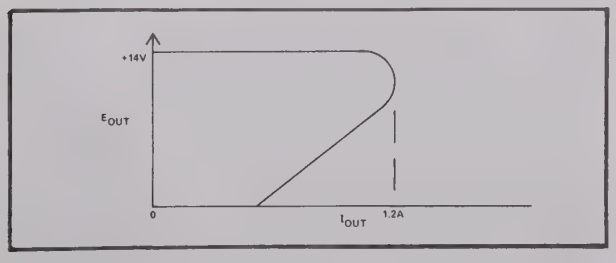



Figure 3-7. "FOLD-BACK" CURRENT LIMITING

3-46. The −12V supply produces a low-ripple −12V dc operating voltage. The supply is enabled by a ground applied to R29 via the FUNCTION switch on the front panel. The regulator consists of Q10, U2, CR21, and series pass elements Q3 and Q4. Current limit protection is provided by Q6 through Q9. Operation of this circuitry is very similar to the +14V regulator. Differences are the use of zener CR21 as a reference for U2 and a current limiting point of approximately 1.1A. Variable resistor R40 allows adjustment of the −12V output.

3-47. The +5V supply consists of Q11 through Q15, U3, and series pass elements Q5 and Q6. It produces a low-ripple +5V dc operating voltage. The regulator consists of Q15, U3, and series pass elements Q5 and Q6. Current limit protection is provided by Q11 through Q14. The regulator is referenced to the −12V supply via divider R58 through R61. Enabling is done in sequence with the −12V supply. Operation is very similar to the +14V supply. Differences are a current limit point of approximately 3.5A and over voltage protection provided by CR26, Q15, and CR28. Fuse F1 provides additional protection at 4A.

## 3-48. 5 MHz Frequency Standard (6160A-4018)

3-49. The 5 MHz Frequency Standard (Drawing No. 6160A-1018) is installed as the −02 Option. It provides a 5 MHz reference drive source for the synthesizer via a STD OUT connector on the rear panel.

3-50. The frequency standard receives operating voltage from the Mother Board (Drawing No. 6160A-1013) whenever ac power is applied to the synthesizer. When the FUNCTION switch is set to OFF, a ground is applied to pin 8 of the frequency standard. This ground causes Q1 to conduct and apply the unregulated +14V input at pins H and 7 to terminal 3 of oscillator, Y1. Since the power supply is not operating, the regulated inputs to pins 1 and 6 are not present and terminal 1 of Y1 is at ground via CR2. The unregulated input between terminals 3 and 1 of Y1 then serve as an operating voltage for the oscillator. When the FUNCTION switch is set to a position other than OFF, the ground to pin 8 is removed. Since the power supply is now operating, regulated inputs of +14V and −12V are applied to pins 6 and 1, respectively. Removal of the ground at pin 8 causes Q1 to cut-off, thus making the applied regulated inputs between terminals 3 and 1 (+26V) of Y1 serve as an operating voltage for the oscillator. Diode CR2 is cut-off because of the −12V input to pin 1. Decoupling of the −12V and +14V inputs is provided via L1, C1 and L2, C2, respectively.

## 3-51. Input Filter Module (6160A-4101)

3-52. The Input Filter Module (Drawing No. 6160A-1001) processes the 5 MHz synthesizer drive input and

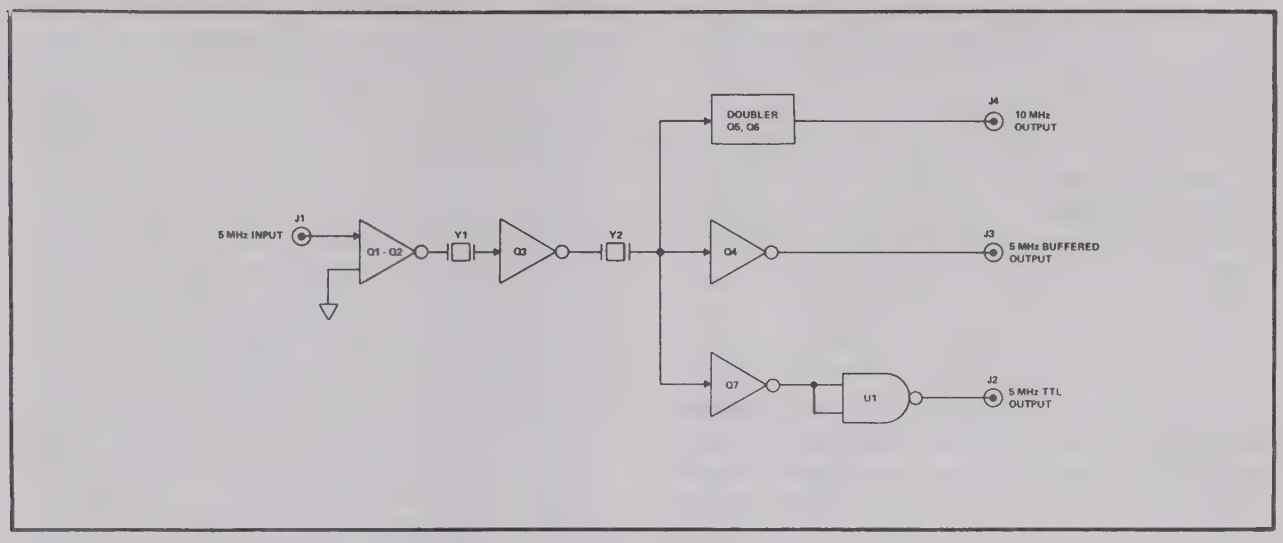



Figure 3-8. INPUT FILTER MODULE BLOCK DIAGRAM

produces two 5 MHz outputs and a 10 MHz output. One of the 5 MHz signals is made available at the rear panel. The other 5 MHz signal and the 10 MHz signal function as internal references within the synthesizer. A block diagram of the circuitry is shown in Figure 3-8.

3-53. The 5 MHz drive input applied to J1 is first processed by the tuned limiter amplifier Q1 and Q2. This circuit functions as a limiter for high level inputs and as an amplifier for low-level inputs. Input signal level requirement is nominally 1V rms ±3 db. The resulting signal at L2 is then filtered by Y1, amplified by driver Q3, and further filtered by Y2. The filtered 5 MHz signal is amplified by Q4 to provide a 1V rms into 50 ohm output at J3. Variable resistor R17 allows adjustment of the signal level at J3. Driver Q7 and NAND gate U1 provide a 5 MHz TTL signal at J2. A 10 MHz signal is provided at J4 by the tuned push-pull amplifier consisting of T3, Q5, Q6 and L4.

## 3-54. Six Digit Generator (6040A-4102)

3-55. 10 HZ STEP LOOP. The 1 Hz and 10 Hz Step Loop can be found on Drawing 6040A-1002, sheet 1. The 50 kHz reference is applied to the 2:1 Divider, U51-12, where it is reduced to a 25 kHz reference signal. This reference is applied to Phase Detector U50-1 where it is compared with the output of the N:1 Divider at U50-3. Output of the Phase Detector is at U50-13 and -2. When the VCO lags the reference signal, an output occurs at U50-13 to the Up Charge Pump. The Up Charge Pump, Q37 and Q36, charges C111 with pulses of current which causes a corresponding voltage rise. The rising voltage is coupled through the low-pass filter C109, C108, L29, C107, C106 and L28 to the varactor diode CR12. The voltage rise causes CR12 to change its capacitance causing an increase in VCO frequency. When the VCO frequency leads the reference signal, the Phase Detector output is at U50-2. In this situation the Down Charge Pump, Q25, conducts and discharges C111 which in turn causes a lowering of the control voltage to the VCO. This results in a decrease in VCO output frequency. The VCO ranges in frequency from 27.5 to 25.025 MHz and consists of CR12, T5, and Q27, with Q26 acting as a buffer to reduce loading. Limiter Amplifiers Q34 and Q35 tend to square the sinusoidal output of the VCO. The squared output is applied to buffer amplifier U44-12, U44-6, and U47-6 to obtain sufficient TTL drive for the N:1 Divider. Another path for the VCO output is through U44-12 and U44-8 to through the 10:1 Divider U42. The output at U42-12 is applied to the 100 Hz and 1 kHz Main Loop where it will be added to the 100 Hz and 1 kHz step loop frequency.

3-56. The N:1 Divider consists of two programmable ten-state counters (U45 and U46), a sixteen-state counter (U49), an AND input flip-flop, and gates U47-8 and U47-12. In this arrangement the 1 Hz and 10 Hz BCD control lines are connected to the ten-state counters U45 and U46, respectively. The buffered TTL output of the VCO is applied to the clock 1 input of U45-8. The number of counts required to get an output from the N:1 divider depends upon what state the counters, U45 and U46, are preset to by the 1 Hz and 10 Hz control inputs. With zeros programmed into the counters it takes 1100 counts

for an output from the N:1. Programming for nines results in a much lower count of 1001. The end of a counting cycle occurs on the second clock pulse to U48-12 after U47-8, 48-9, -10, -11, and -12 are high. This results in U48-6 going high which is buffered through U47-12 to the Phase Detector, U50-3. The low output from U48-8 initiates the load inputs of U45 and U46. This causes any data appearing on the 1 and 10 Hz control lines to be loaded.

3-57. 100 HZ AND 1 KHZ STEP LOOP. This step loop can be found on schematic drawing number 6040A-1002, sheet 2. The circuit arrangement is quite similar to 1 Hz and 10 Hz Step Loop. Here, a 100 kHz reference frequency is divided by two at U39 to provide a 50 kHz reference signal. This reference is applied to Phase Detector U38-1 which compares it with the N:1 Divider output to U38-3. The outputs of the Phase Detector, U38-13 and -1, are applied to Up and Down Charge Pumps (Up - Q31 and Down - Q24). The resulting voltage from the charging and discharging of C112 is filtered by C81, C80, L21, C79, C78, and L20 and applied to varactor diode CR10 in the VCO to achieve a phase lock condition. Part of the filtered control voltage to the VCO is coupled through rc filter R110 and C82 to a voltage follower, U37. The output from U37 is a feedback voltage to provide more or less current for the Up Pump. It also provides a control voltage to a pair of diode voltage clamps, CR8 and CR89 in the Main Loop VCO control voltage circuit. The reason for this is discussed in the 100 Hz and 1 kHz Main Loop description. The VCO is almost identical to the previously discussed 10 Hz Step Loop VCO except that its output frequency is 24.45 to 19.5 MHz. The output is applied through buffer gates U30-12, U30-6, U31-11, and U31-3 to provide sufficient TTL drive for the N:1 Divider. A part of the VCO output is buffered by U30-12 and U30-8 for application to the Main Loop Mixer.

3-58. The buffered VCO output frequency is applied to the N:1 Divider input at U32-8. The number of counts required to achieve an output from the divider at U36-14 depends upon the preset states of U32 and U34. Preset data comes from the 100 Hz and 1 kHz Input lines from the Computer. With U32 and U34 programmed to zero a full count of 480 is required to get an output pulse from the N:1 Divider at U36-14. When U36-15 goes low as a result of this, data present on the 100 Hz and 1 kHz Input lines are loaded into U32 and U34.

3-59. 100 HZ AND 1 KHZ MAIN LOOP. One input to the Main Loop is from the 1 Hz and 10 Hz Step Loop and ranges from 2.75 to 2.5025 MHz. This input is first applied to a 5:1 Divider, U29, resulting in an output frequency of .55 to .505 MHz. The output of the 5:1 Divider is applied to one input of the Phase Detector, U28-1. The other input to the Main Loop is from the 100 Hz and 1 kHz Step Loop and ranges from 24.45 to 19.5 MHz. This input signal is applied through C51 to U26-11, the Frequency Mixer. The other input to the mixer is the buffered Main Loop VCO frequency ranging from .25 to 20 MHz. These inputs to U26 are mixed and the resulting difference frequency, .55 to .5 MHz, is filtered through C59, C60, and L27 to amplifier Q20. Transistor amplifier Q20 operates in a saturated mode and provides a TTL level square wave output from its linear input. The TTL signal at .55 to .5 MHz is applied to the other input of the Phase Detector, U28-3. The bistable outputs of the Phase Detector, U28-13 and -2, are coupled to the Charge Pumps. The resulting control voltage alters the VCO frequency to achieve a phase lock. Output frequency from the VCO is applied through buffer drivers to the Mixer. Another output path is through buffer gate U25-8 to a 10:1 Divider, U24. The 2.5 to 2 MHz output from the divider, U24-12, is applied to the input of the 10 kHz and 100 kHz Main Loop.

3-60. The control voltage created by the Charge Pumps in conjunction with charge capacitor C71 is contained within a predetermined voltage "window". The window limits are determined by voltage clamps CR8 and CR9. These clamps are controlled by a control voltage from the Step Loop voltage follower U37. This control voltage is derived from the Step Loop VCO control voltage. The purpose of this control is to pull the Main Loop VCO along with the Step Loop VCO when large frequency changes are required. This keeps the Main Loop within a close range to achieve a rapid phase lock. In addition, Main and Step Loop VCO's track very closely. This occurs because the varactor diodes, CR9 of the Main Loop and CR10 of the Step Loop are matched.

3-61. 10 KHZ AND 100 KHZ STEP LOOP. This Step Loop schematic diagram can be found on drawing 6040A-1002, sheet 4. A 1 MHz reference signal from J1 is applied to buffer gates U16-11 and U16-8 for application to the

10:1 Divider U15. Part of the 1 MHz signal goes through U16-3 and U16-6 to J3 which is applied to the Computer as the clock signal. The 100 kHz references out of the 10:1 Divider U36-11 is applied to one input of the Phase Detector U14-1. The other input to the Phase Detector is from the N:1 Divider. Outputs from the Phase Detector, U14-13 and -2 are applied to the Charge Pumps which in conjunction with the charge capacitor C17 provides the VCO control voltage. This voltage is filtered and applied to the VCO to achieve a phase lock condition. Part of the VCO control voltage is fed back through voltage follower U13 to the Main Loop VCO control voltage clamps. The U13 output is also buffered by Q7 and applied to the Up Pump to supply the necessary current. The VCO ranges from 20.5 to 30.4 MHz and functions like the VCO's previously described. It's output is buffered to the N:1 divider and to the Main Loop Mixer.

3-62. Input to the N:1 Divider is at U6-8. The presettable counters are U6 and U8. Data on the 10 kHz and 100 kHz control lines are applied to nines complement circuits U2, U4 and U7. The nines complement of the control line data presets the counters. When the Control Input lines are at zero the nines complement circuits load nines into the counters U6 and U8. Therefore, fewer counts are required for an output so that the input will be divided by 205. When the Computer commands to the 10 KHz and 100 kHz Control Inputs are nines, the N:1 will divide by 304.

3-63. 10 KHZ AND 100 KHZ MAIN LOOP. One input to the Main Loop (drawing 6040A-1002, sheet 5) is from the 100 Hz and 1 kHz Main Loop. This input varies from 2.5 to 2 MHz and is applied through a 5:1 Divider, U32, to one input of the Phase Detector, U21-3. The other input to the Main Loop is from the Step Loop. This input ranges from 20.5 to 30.4 MHz and is applied to one input of the Frequency Mixer, U19. The other mixer input is from the VCO, which ranges from 20 to 30 MHz, and is applied through U18-12 and U18-8 to U19-5. The difference frequency .5 to .4 MHz, from the mixer is coupled by a low pass filter (C39, C38, L13, C41, and L14) to the linear to TTL amplifier Q14. Output from Q14 is applied to the other input of the Phase Detector, U21-1. Bistable outputs from the Phase Detector go to the Charge Pumps for production of the VCO control voltage to achieve phase lock. The VCO output is buffered through U18 and U17 to achieve sufficient drive at the output, J2, for connection to the 1 MHz Digit Generator section.

3-64. The varactor diodes CR1 and CR2 in the Step and Main Loops are also matched to provide close tracking between the oscillators. Voltage limits are also placed on the VCO control voltage to keep both the Main and Step Loops close together during large step changes. In this main loop, the upper window stop is controlled by operational amplifier U23 and CR3. This circuit insures that no current will be drawn from control signal until the upper stop is reached. The lower window stop is set by CR4 and CR5. Control voltage from the step loop is applied to U23-3 and the anode of CR4.

## 3-65. 1 MHz Digit Generator

3-66. The 1 MHz Digit Generator Module Set, which consists of a main loop and step loop is divided among three modules. These modules are the 1 MHz Step Loop (6160B-4153-1), 1 MHz Main Loop VCO (6160B-4153-2) and the 1 MHz Main Loop Phase Detector 6160B-4153-3. The input frequency to the module set ranges from 20 to 30 MHz. Increments relating to the 1 MHz deçade are added to the incoming frequency and result in an output frequency range from 10 to 20 MHz.

3-67. 1 MHZ STEP LOOP (6160B-4153-1). The Step Loop schematic diagram can be found on drawing number 6160B-1053, sheet 1. A 5 MHz reference signal from the Input Filter is applied through J1 to a 5:1 Divider, U4-6. One of the 1 MHz outputs, U4-2 is applied to one input of the Phase Detector, U5-3. The other output, U4-12, goes to J2 where it is connected to the Six Digit Generator for use as a reference signal. The other input to the Phase Detector, U5-1, comes from the N:1 Divider. Outputs from the Phase Detector, U5-2 and -8, are applied to the Charge Pumps. Transistors Q7 and Q11 comprise the Up Charge Pump while Q8 and Q9 are the Down Charge Pump. A slight leakage current is caused by R27 in the Down Charge Pump circuit so that the Up Charge Pump will be normally on. The current pulses from either pump charge the integrator R20 and C29. Voltage across the integrator is applied to the low pass filter, C26, C22, C23, L8, C24, C19, C29, L6, C21, L4, C16, C11, and L3. The filtered variable dc control voltage biases the cathode of the varactor

diodes CR2 and CR3. A fixed bias for the anode side of CR2 and CR3 is provided by Q10. The effect of the dc control voltage is to alter the VCO frequency so as to achieve phase lock condition in the loop. A portion of the dc control voltage to the VCO is fed to operational amplifier U3 which feeds back a voltage through Q6 and R19 to the Up Charge Pump. This feedback compensates changes in loop gain due to the non-linearity of the varactor tuning diodes and the division ratio changes of the N:1 Divider. The VCO output from the oscillator transistors, Q4 and Q5, is fed to limiter amplifier Q3 and Q2 and Schmitt trigger U1-12 to provide a TTL square wave output. Part of the output is buffered by U1-8 for application to the following 10 MHz Digit Generator. The other part is buffered by U1-6, U2-8, and U7-12 for application to the N:1 Divider.

3-68. The N:1 Divider consists of J-K flip-flops U6 and U8, programmable counter U9, and gates U10-6, U7-6, and U7-8. Control lines from the Computer go through a nines complement circuit (U11 and U10) before presetting the counter, U9. Toggle counting is performed by U6-5, U9, and U8-15. Gates U7-6 and U7-8 compare the outputs from the counting devices and detect the end of the counting cycle. At the end of cycle detection, flip-flop U6-9 and U8-11 reset the counter elements and cause new data to be loaded into U9. With a zero binary command from the Computer, the N:1 Divider adjusts to provide an 18:1 division ratio. As the binary commands increase in magnitude the division ratio increases to a maximum of 37:1.

3-69. 1 MHz MAIN LOOP PHASE DETECTOR (6160B-4153-3). The Main Loop Phase Detector schematic diagram can be found on drawing number 6040A-1004. The 20 to 30 MHz signal from the preceeding decade is applied through J3 and 10:1 divider, U2-2, to one of the Phase Detector inputs, U3-1. This 2 to 3 MHz signal is compared with the 2 to 3 MHz intermediate frequency from the Main Loop VCO and mixer module. The IF is applied through J4 to low pass filter C17, C18, C19, and L8. The signal is amplified by Q6 and applied to a Schmitt trigger, U4, to provide a TTL square wave to the other input of the Phase Detector, U3-3. Outputs from the Phase Detector, U3-13 and 8, are applied to the Charge Pumps. The Up Charge Pump consists of Q2 and Q3 and the Down Charge Pump is Q4 and Q5. As in the Step Loop Down Pump, this Down Pump has a resistor, R20, which causes enough leakage current to keep the Up Pump normally on. The integrator for the current pulses from the pumps is R14 and C10. The resulting control voltage is filtered by low pass filter C11, C12, L6, C13, L7, and C14. Remaining filtering occurs in the Main Loop VCO to J1 module whose input is connected.

3-70. To keep the Main Loop tracking the Step Loop during large step changes, the control voltage is kept within constraints established by a voltage window. The tie point for the voltage limiter circuit is between L6 and L7. The lower window stop is established by CR2 while a more precise upper window stop is established by an operational rectifier, U1 and CR1. Current source Q1 in conjunction with R5 establishes a reference level for U1. A buffered version of the Step Loop control voltage is applied to J2 and labeled $V_c$. This tracking voltage approximately positions the Main Loop VCO so that the Main Loop can capture the signal and the Phase Detector can lock.

3-71. 1 MHZ MAIN LOOP VCO. The Main Loop VCO schematic diagram can be found on drawing number 6160B-4153, sheet 2. The VCO control voltage from the Phase Detector module is applied through J2 and remaining low pass filter elements to the varactor tuning diodes CR1 and CR2. The control voltage cause the capacitance of the varactor diodes to change, which alters the output frequency of the VCO. With the control voltage biasing one side of the diodes, the other side is fixed biased ($V_b$) by the same source as in the Step Loop diodes. Diodes in the Main Loop and Step Loop are cross matched so that they will track closely. The output signal from the Main Loop VCO goes through limiter amplifier Q3 and Q4 and Schmitt trigger U2-12. The resulting TTL square wave is buffered by U2-8 and divided by 2:1 in U3 to provide a 10 to 20 MHz output to the following decade. Another output path from U2-12 is buffered by U2-6 and applied to one input of the mixer, U1-5. The 18 to 37 MHz output from the Step Loop is applied to J4 where it is attenuated by R1 and R2 and filtered by C1 through C3 and L1 through L3 before being applied to the mixer, U1-10. Resulting sum and difference frequencies from the mixer are applied to filter C10 through C13 and L4 which passes the difference frequency. This intermediate frequency at J4 is connected to the Main Loop Phase Detector Module where it filtered and amplified for application to the phase detector.

## 3-72. 10MHz D.U. Step Loop VCO Module (6160A-4107-1)

3-73. The 10MHz D. U. Step Loop VCO Module (Drawing No. 6160A-1007-1) produces a 70 to 140MHz step loop signal for the 10MHz digit section. This signal is available in 10MHz steps which correspond to 10MHz decade commands of 0 to 7. A block diagram of the circuitry is shown in Figure 3-9.

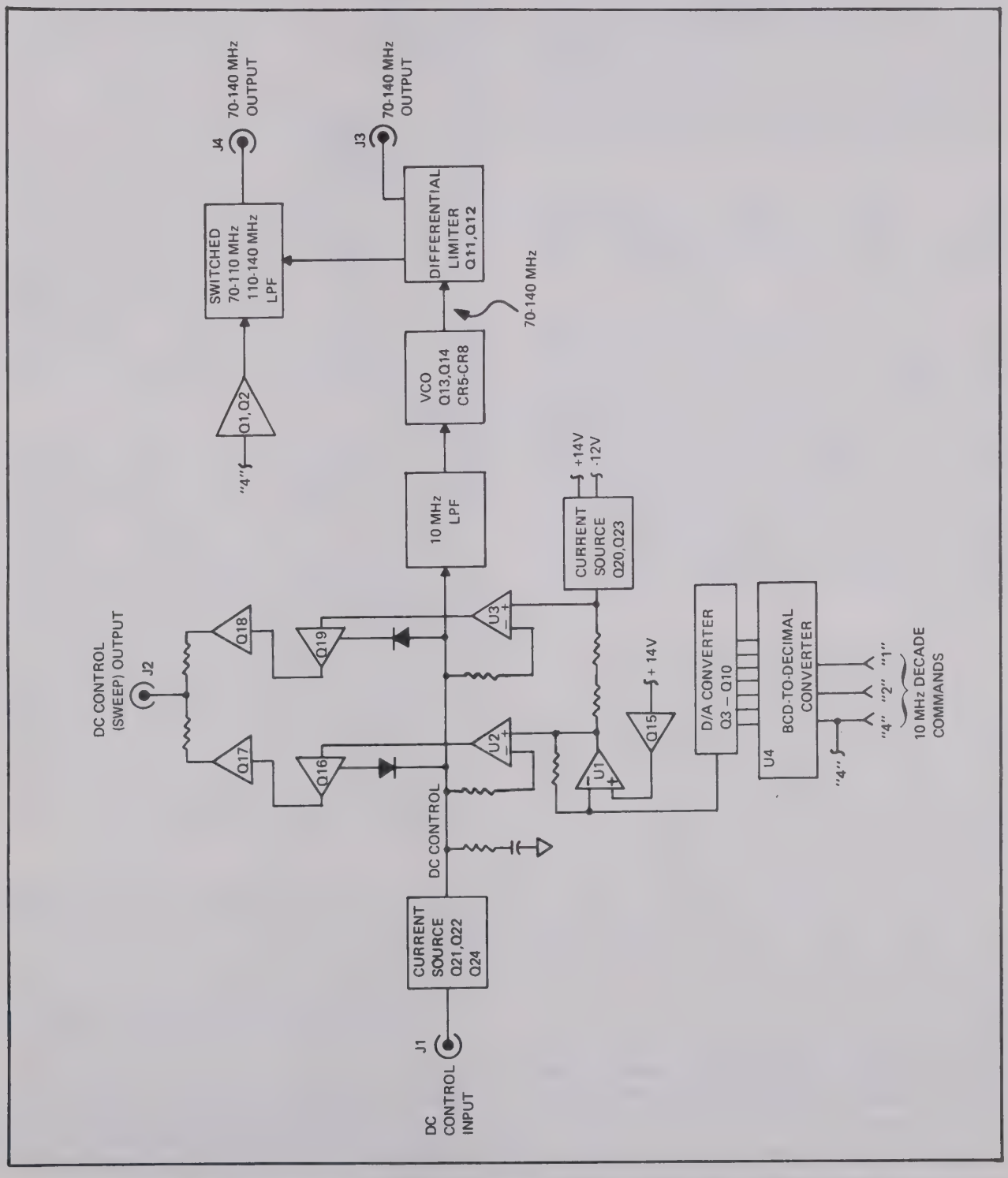



Figure 3-9. 10 MHz D. U. STEP LOOP VCO MODULE BLOCK DIAGRAM (6160A-4107-1)

3-74. The dc control voltage applied to J1 is processed by current sources Q21 and Q22 which produce a dc control across C25 via R57. In a static condition (OV input), the opposing currents supplied through Q21 and Q22 counterbalance each other such that the voltage across C25 is constant. A positive going input at J1 decreases conduction of Q22, thus providing an increase in voltage across C25 via current source Q21. The opposite is true for a negative going input to J1. Transistor Q24 supplies bias current for Q22 in relation to any change in voltage across C25. Variable resistor R60 allows adjustment of the threshold current switching point of Q21 and Q22.

3-75. A 10MHz low-pass filter consisting of C19, C20, C21, C24, L14, and L15 removes any ripple at or above 10MHz in the voltage across C25. This filtered dc control voltage is then applied to a 70 to 140MHz VCO.

3-76. The VCO composed of CR5 through CR8, Q14, and a printed circuit inductor produces a 70 to 140MHz signal dependent upon the dc control voltage across C25. Capacitance value of varicaps CR5 through CR8 depends on the applied control voltage. There varicaps together with the tapped printed circuit board inductor form a tuned circuit. Conduction of Q14 develops a signal that is coupled via C16 to the tuned circuit. Regenerative feedback to the base of Q14 via R30 sustains oscillations at the resonant frequency of the tuned circuit. Transistor Q13 buffers the VCO signal, which is then coupled via T3 and C12 to Q12.

3-77. Transistors Q11 and Q12 form a differential limiter which translates the 70 to 140MHz VCO signal to a squarewave. The output of Q11 is applied to J3 via R18 and T1. The output of Q12 is passed through a switched, low-pass filter consisting of C1 through C4 and L1 through L5. When the VCO frequency is from 70 to 100MHz (10MHz decade commands of 0 through 3), transistor Q1 is switched on by the OV ("4" bit absent) emitter voltage via CR9. Conduction of Q1 turns on Q2 which then turns on diodes CR1 through CR4. Capacitors C1 and C4 are subsequently placed in parallel with C2 and C3 and lower the switched filter cut-off frequency to nominally 110MHz. Presence of a 10MHz decade command of 4 thru 7 (4 bit present) produces a +2V or greater emitter voltage at Q1, thus turning it off. Q2 is also switched off by this condition, and diodes CR1 through CR4 are switched off by the resulting −12V collector voltage of Q2. Capacitors C1 and C4 are subsequently disconnected from the switched filter, increasing its cut-off frequency to nominally 140MHz.

3-78. Presteering the VCO frequency to approximately the correct point is done via U4, Q3, through Q10, and U1 through U3 together with Q16, Q19, and Q20, Q23. The 10MHz commands (4–2–1) are converted to decimal information by U4. This decimal information then controls conduction of Q4 through Q10, which produce proportional decimal weighted voltages at the input to U1. The resulting output of U1 is compared to the dc control voltage applied to the VCO via U2 and U3. If the potential difference is greater than 0.3V, the output of U2 or U3 is then used to force the VCO control voltage to within ±0.3V of the correct value by conduction of Q16 or Q19.

3-79. The 10MHz decade commands are converted to decimal information by U4. Presence of a decimal output (OV) from U4 turns off the diode associated with Q4 through Q10 and allows the transistors to provide a proportional decimal weighted voltage at their collectors. Absence of a decimal output (+2 to +5v) from U4 turns on the diode associated with Q4 through Q10, which switches the transistors off. Transistor Q3 together with R8 form a temperature compensated bias supply for Q4 through Q10. Variable resistors in the emitter circuits of Q4 through Q10 allow adjustment of the decimal weighted voltage increments.

3-80. Integrated circuit U1 is a differential, operational amplifier. It compares the decimal weighted output of Q4 through Q10 to a fixed reference established by Q15. Variable resistor R70 allows adjustment of the reference and subsequently the "O" decimal voltage equivalent. The resulting output of U1 produces a voltage across R36 and R42 that is decimal weighted to the 10MHz commands. This voltage is applied to one input of comparator amplifier U2. Transistors Q20 and Q23 produce a reference current through R42 and R36 which establishes a maximum voltage reference input to U3, another comparator amplifier. Since this reference input to U3 is affected by the output of U1, the inputs to U2 and U3 track approximately 0.6V apart, thus establishing a "window" voltage dependent upon the 10MHz commands. An example of the "window" voltage is shown in Figure 3-10.

3-81. Comparator amplifiers U2 and U3 each receive a sample of the dc control voltage at their other input via R35 and R41. Should this input be above or below the other input to U2 or U3, one or the other conducts and switches on transistor Q16 or Q19. Conduction of Q16 or Q19 then provides a rapid charge or discharge current to C25 via CR17 or CR19 that brings the dc control voltage to within 0.6V of its correct value. Transistors Q17 or Q18 are also switched on by conduction of Q26 or Q19 and provide a plus or minus sweep control output at J2. This sweep control voltage causes the input to J1 to rapidly approach its correct value via another circuit in the 6160A-4106-1 module.

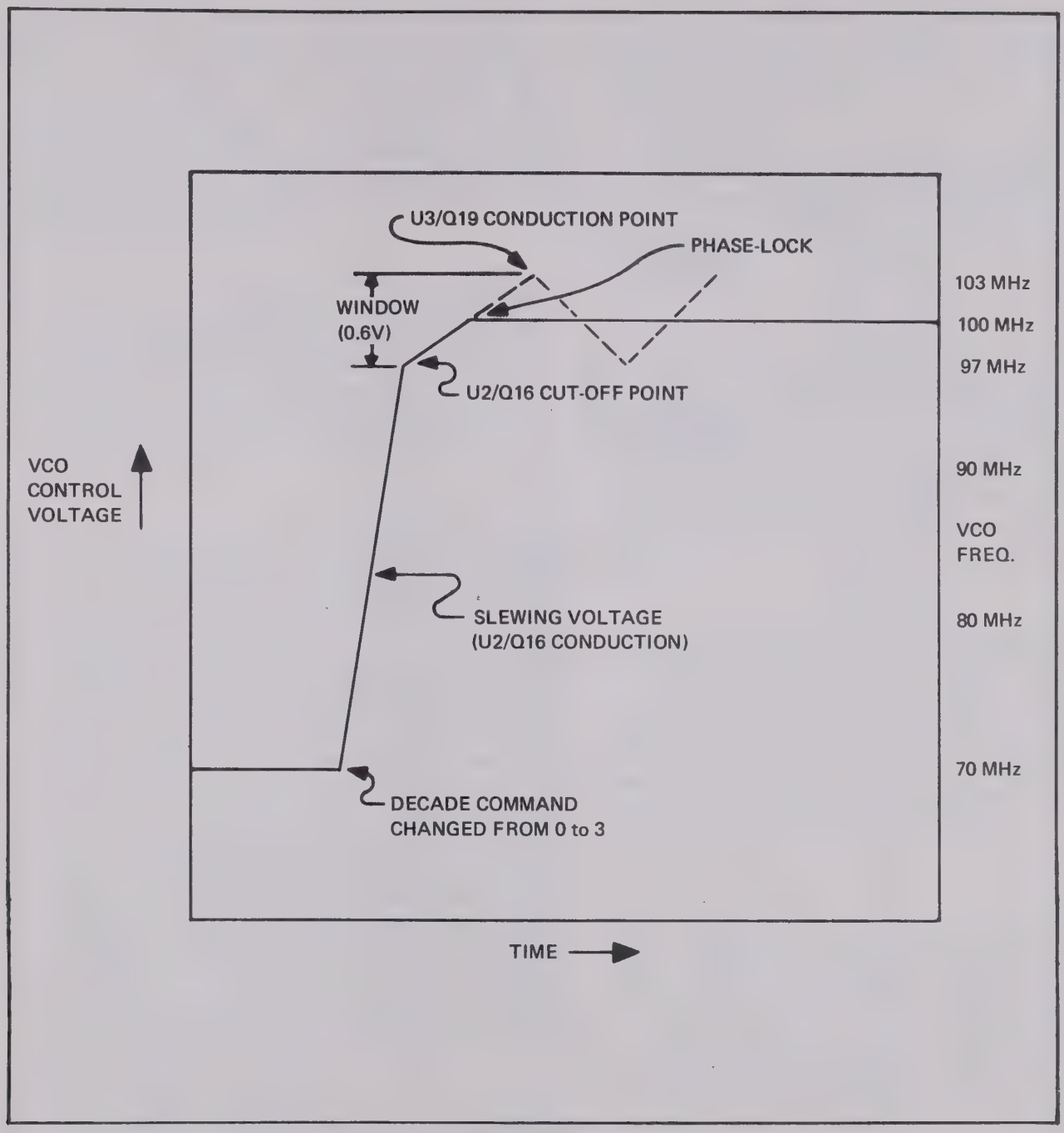



Figure 3-10. VCO "WINDOW" VOLTAGE

## 3-82. 10MHz D.U. Step Loop P.D. Module (6160A-4106-1)

3-83. The 10MHz D.U. Step Loop P.D. Module (Drawing No. 6160A-1006-1) receives a 10MHz reference signal and a 70 to 140MHz step loop signal and dc sweep voltage from the 10MHz digit section. It compares the two rf signals and produces a dc control voltage which phase-locks the 10MHz step loop section. The dc sweep voltage (present when the 10MHz step loop is not phase-locked) is processed to provide a rapid change in dc control voltage output necessary to achieve phase-lock. A block diagram of the circuitry is shown in Figure 3-11.

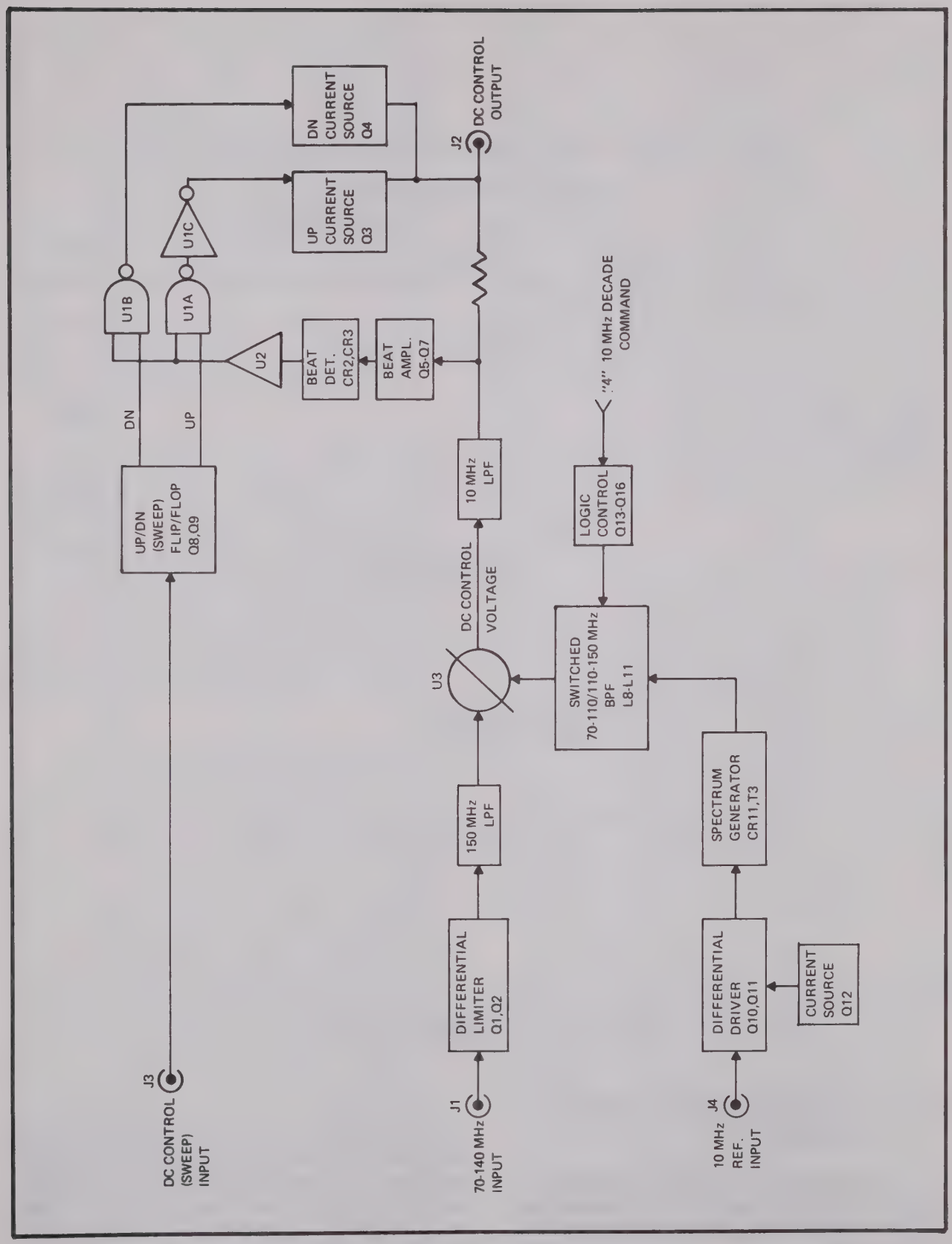



Figure 3-11. 10 MHz D. U. STEP LOOP P. D. MODULE BLOCK DIAGRAM (6160A-4106-1)

3-84. The 10MHz reference input at J4 is amplified by differential driver Q10 and Q11. Transformer T4 sums the outputs of Q10 and Q11 and couples the signal to the following spectrum generator. Transistor Q12 provides a constant current for Q10 and Q11. Variable resistor R27 allows adjustment of this current and subsequently the output drive level of the signal at T4.

3-85. Step-recovery diode CR11 together with T3 form a spectrum generator which produces a series of pulses rich in harmonics of 10MHz. Variable resistor R34 adjusts the bias on CR11. The resulting spectrum signal is tapped at T3 and applied via an impedance matching pad consisting of R39, R40, and R41 to a switched, band-pass filter.

3-86. The switched filter consists of L1, L2, L8 through L11, L20, C31, and C34 through C39. It passes only frequencies between 70 to 110MHz or 110 to 150MHz, depending upon the condition of the "4" 10MHz decade command. Absence of this command (OV), turns off Q13 and Q16 and switches on Q14 and Q15. Conduction of Q15 turns on diodes CR4 through CR7 and places C37, C39 in parallel with C36 and C38. Since Q16 is off, diode CR18 is also off and L11 together with C35 are in series with L20. This condition provides an overall 70 to 110MHz band-pass characteristic for the filter. Presence of the "4" command (+5V), turns on Q13 and Q16 and switches Q14 and Q15 off. Conduction of Q16 turns on CR18 via CR8 and grounds the junction of L20, L11. With Q15 off, diodes CR4 through CR7 are also off, which disconnects C37 and C39. Overall response of the band-pass filter is subsequently 110 to 150MHz in the presense of a "4" bit command. The resulting filtered band-pass signal is then applied directly to one input of phase detector U3.

3-87. The 70 to 140MHz input at J1 is amplified by differential driver Q1 and Q2. The resulting amplified signal is summed in T1 and coupled via a 150MHz low-pass filter composed of L6, L7, and C7 through C12 to one input of U3. Balanced mixer U3 compares the 70 to 140MHz input at pin 1 to the 70 to 100MHz or 110 to 140MHz input at pin 6 and produces a plus or minus output at pin 4 which is proportional to any offset. The 10MHz low-pass filter composed of L12, L21, and C13 through C16 removes any ripple above 10MHz. Variable capacitor C13 allows adjustment of the filter-"notch" response to 10MHz. The resulting filtered signal is applied via R53 to J2. This signal or dc voltage is then used to control the precise frequency of a VCO in the 6160A-4107-1 Module and phase-lock the 10MHz digit step loop.

3-88. When the 10MHz digit, step loop is out-of-lock, the circuitry consisting of Q3 through Q9, U1, and U2 produces a positive or negative dc output at J2. This output causes the 10MHz digit step loop to approach the correct phase-lock point.

3-89. Presence of a positive or negative dc input to J3 exists when the step loop is grossly un-locked. This input causes flip-flop Q8 and Q9 to provide a positive gate to U1A or U1B, depending on the polarity of the input to J3. If a positive input is present, the output of Q9 is +5V and U1A receives a positive gate. Should the input to J3 be negative, the output of Q8 is +5V and U1B receives a positive gate.

3-90. NAND gates U1A and U1B receive an enable command (+5V) from U2 whenever a beat signal is present at J2. This beat signal exists whenever there is a difference between the two inputs to phase detector U3. AC amplifiers Q5 through Q7 amplify the beat signal, which is then peak detected by CR2 and CR3. The resulting positive voltage across C21 is converted to a +5V enable command by U2 and applied to NAND gates U1A and U1B.

3-91. When both inputs to U1A or U1B are high (positive), the low output switches on up or down current sources Q3 and Q4 and produces a positive or negative dc output at J2. Current source Q3 is switched on via inverter U1C when both inputs to U1A are positive (up sweep) and produces a positive voltage at J2. A negative voltage at J2 is provided via Q4 which is switched on by U1B (down sweep).

## 3-92. 10 MHz D. U. IF Mixer Module (6160A-4108)

3-93. The 10 MHz D. U. IF Mixer Module (Drawing No. 6160A-1008) combines the 80 to 160 MHz main loop and 70 to 140 MHz step loop signals of the 10 MHz digit section. The resulting 10 to 20 MHz difference is then used to phase-lock the main loop in the 10 MHz digit section. A block diagram of the circuitry is shown in Figure 3-12.

3-94. The 70 to 140 MHz step loop input to J2 is amplified by tuned driver Q3. The signal at tapped indicator T2 is coupled by C15 to a 140 MHz low-pass filter consisting of L5 through L9, C16, and C17. This filter removes any ripple above 140 MHz and applies the signal to pin 6 of mixer U1 where it functions as a linear input. An 80 to 160 MHz main loop input to J1 is translated to a symmetrical squarewave by tuned differential limiter Q1 and Q2. Positive going inputs to Q1 cause it to conduct the maximum current available through R1 and R2. Transistor Q2 is cut-off during this period and no signal is developed in its collector. When the input to Q1 goes negative, it is cut-off and Q2 conducts the maximum current available through R1 and R2. The resulting 80 to 160 MHz squarewave at T1 is filtered by C6 through C10, L1, and L2 to remove any ripple above 160 MHz. Capacitor C42 couples the filtered signal to pin 1 of mixer U1 where it functions as a switching input.

3-95. Mixer U1 combines the 70 to 140 MHz step loop and 80 to 160 MHz main loop signals. A 20 MHz low-pass filter consisting of C18 through C21, C26 through C28, and L14 through L16 selects the 10 to 20 MHz difference frequency. Driver Q4 amplifies the 10 to 20 MHz resultant which is then applied to Q5. FET Q6 functions as a variautomatic amplitude control of the output signal from the emitter and collector of Q5. The collector signal of Q5 is applied to J4, via tapped inductor T3, while its emitter signal is applied to Q7 via R25 and C35. Driver Q7 amplifies the emitter output of Q5 which is then applied to buffer Q10 and amplitude detector CR1, CR2. Buffer Q10 produces a variable load at the output of Q4. This variable load provides

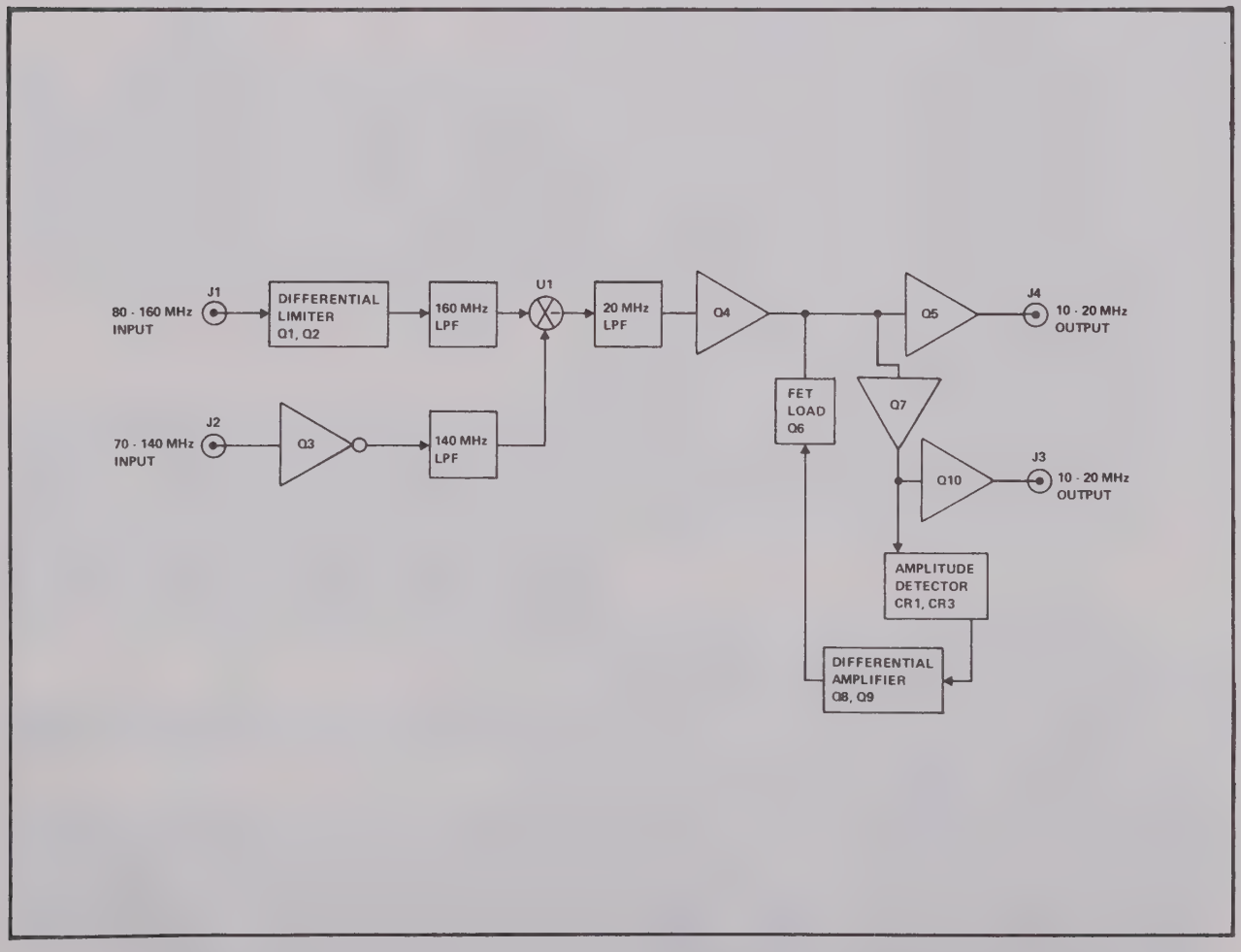



Figure 3-12. 10 MHz D. U. IF MIXER MODULE BLOCK DIAGRAM

10 to 20 MHz output that is isolated from the amplitude detector to J3. Diodes CR1 and CR2 detect the amplitude of the collector signal from Q7 and provide a proportional dc input to Q8. Transistors Q8 and Q9 form a differential amplifier which amplifies any difference between the reference voltage set by R35 and the dc input from the amplitude detector. The difference output from Q9 drives FET Q6. Subsequently, the amplitude of the outputs at J3 and J4 are automatically controlled.

## 3-96. 10 MHz D. U. Main P. D. Module (6160A-4109)

3-97. The 10 MHz D. U. Main P. D. Module (Drawing No. 6160A-1009) combines the 10 to 20 MHz output from the 1 MHz digit section with 10 to 20 MHz signals from the 10 MHz main loop. The resultant dc output then determines the frequency and phase of the 10 MHz main loop. A block diagram of the circuitry is shown in Figure 3-13.

3-98. The 10 to 20 MHz input from the 1 MHz digit section at J4 is translated to a symmetrical squarewave by differential limiter Q1 and Q2. Negative going inputs to Q1 cause it to conduct the maximum available current through R1. Transistor Q2 is cut-off during this period and no signal is developed in its collector. When the input to Q1 goes positive, it is cut-off and Q2 conducts the maximum current available through R1. The resulting 10 to 20 MHz squarewave at T1 is then coupled, via C7, to phase detector U1, where it functions as a switching input. Phase detector U1 receives a linear 10 to 20 MHz input from J3. This input is derived from the 10 MHz main loop. A low-pass filter consisting of C18 through C20 and L7 removes any ripple above 20 MHz.

3-99. Phase detector U1 combines the two 10 to 20 MHz inputs and produces an output that is the difference frequency. If both inputs are equal in frequency, the output is a dc voltage proportional to the cosine of the phase relationship between the two inputs. A low-pass filter consisting of C21, C22, C24, L8, and L9 removes any ripple above 7 MHz. The resulting difference frequency or dc voltage is applied, via R50, to J2. Presence of a dc voltage output from U1 (main loop phase-locked) causes FET gate Q19 to conduct which grounds the junction of R49 and R51. However, when the output of U1 exceeds 1 MHz, Q19 is cut-off and a dc voltage derived from the output of U2 is applied, via R49 and R51, to J2.

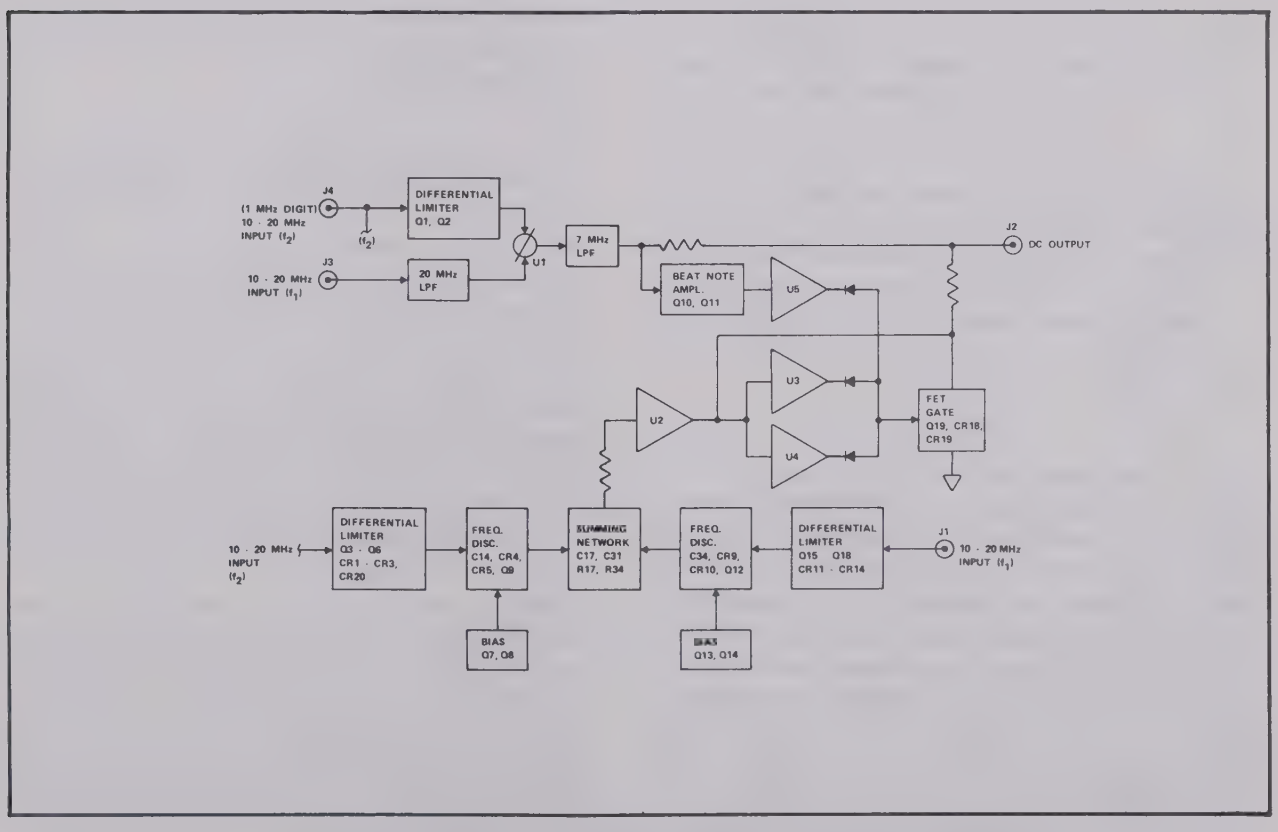



Figure 3-13. 10 MHz D. U. MAIN P. D. MODULE BLOCK DIAGRAM

3-100. Amplifiers U3 through U5 control conduction of FET gate Q19 via AND gate CR15 through CR18. FET Q19 is conducting when the difference frequency output of U1 is less than 1 MHz. A difference frequency greater than 1 MHz turns off Q19 and makes available to J2 the dc output of U2 via R49 and R51. Beat note amplifier Q10 and Q11 amplify the difference frequency output of U1 which then initiates turn-off of Q19. The collector signal of Q11 is rectified by CR6 and CR7 to provide a positive dc input to U5. Operational amplifier U5 produces a positive output under this condition which turns off CR17. Sequential with this condition, U3 and U4 (to be described later) also produce positive outputs that turn off CR15 and CR16. With CR15 through CR17 off, CR19 conducts and the resulting voltage (0V) at the junction of CR18 and R48 turns off FET, Q19. The dc output from U2 is thus summed with the difference frequency output of U1 and made available to J2.

3-101. Comparison of the 1 MHz digit section signal (J4) and the 10 MHz main loop signal (J1 and J3) is done using two discriminators shown in the block diagram. The resulting difference is then summed and converted to a dc voltage proportional to the offset. This dc voltage is made available to J2 when any difference greater than 1 MHz exists between the inputs to J1 or J4. Since both discriminators operate in an identical manner, only the one receiving an input from J4 is described. It should be noted that the input to J1 is identical, except for amplitude, with the input to J3.

3-102. The 10 to 20 MHz input to J4 is coupled via C9 to a differential limiter consisting of Q3 through Q6 and diodes CR1 through CR3 and CR20. Operation of Q3, Q4 and Q5, Q6 is similar to Q1 and Q2 described previously. Diodes CR2 and CR3 provide temperature compensated limiting of the output from Q3 and Q4. Sharp cut-off of Q3 and Q4 is provided via CR1 and CR20.

3-103. Discriminator CR4 and CR5 together with Q9 process the resulting squarewave signal coupled via C14 and produces a dc current proportional to the frequency. Temperature compensated bias is provided via Q7 and Q8. The resulting dc current from Q9 is then summed through R17 with the output of a similar discriminator, but of opposite polarity via R34. The resulting difference current is then amplified by U2 to produce a dc voltage proportional to the difference frequency between J1 and J4. This dc voltage is made available to J2 and also applied to U3 and U4. Comparator amplifiers U3 and U4 produce a turn off voltage to CR15 and CR16 (positive output) when the dc voltage is proportional to a difference frequency greater than 1 MHz. Since beat note amplifier Q10 and Q11 also causes CR17 to be cut-off via U5 at this time, FET gate Q19 described previously is cut-off. The dc output from U2 is thus summed with the output of U1 and made available at J2.

## 3-104. 10 MHz D. U. Main Loop VCO Module (6160A-4110)

3-105. The 10 MHz D. U. Main Loop VCO Module (Drawing No. 6160A-1010) produces an 80 to 150 MHz output containing the 10 MHz digit information. This signal is available in 10 MHz increments and corresponds to the 10 MHz decade commands. Any previous digit information is included, thus providing a total range in output from 80.000000 to 159.99999 MHz. A block diagram of the circuitry is shown in Figure 3-14.

3-106. The dc input to J1 together with the BCD 10 MHz decade commands applied to U4 produce a dc control voltage across C6 that determines the output frequency of an 80 to 160 MHz voltage controlled oscillator (VCO). Transistors Q1 and Q3 integrate the dc input at J1 and provide fine tuning of the VCO frequency. An up frequency charge current for C6 is provided by Q1. Down frequency charge current is provided by Q3. Temperature compensation for Q1 and Q3 is provided via diode connected Q2 and Q4. Variable resistor R3 allows adjustment of the VCO frequency for a given dc input to J1.

3-107. BCD 10 MHz decade applied to U4 produce an incremental step voltage across C6 via a presteering and limit stop circuit consisting of Q10 through Q15 and U1 through U3. The inverted 1-2-4 outputs from U4 (0V = true) turn off associated diodes CR9, CR11, and CR13. Transistors Q10 through Q12 then provide 1-2-4 weighted currents via R27, R28, and R29 to operational amplifier, U3. This weighted current input to U3 is then added to its output developed across R35 through R38. Differential amplifiers U1 and U2 apply the resulting presteering current proportional to the 10 MHz decade commands to C6 via CR2 and CR3. Temperature compensation is provided by Q13. Transistors Q14 and Q15 provide a reference current input to U1 and U2, adjustable by R38. This current input establishes an upper limit stop for U1 and a lower limit stop for U2. Should the dc control voltage developed across C6 exceed the reference, U1 or U2 clamp the dc control voltage at the reference. Variable resistor R33 allows adjustment at the low end of the dc control voltage, while R36 adjusts the high end. The resulting dc control voltage is passed through a 10 MHz low-pass filter consisting of C8 through C11 and L5 to remove any ripple above 10 MHz and applied to a VCO.

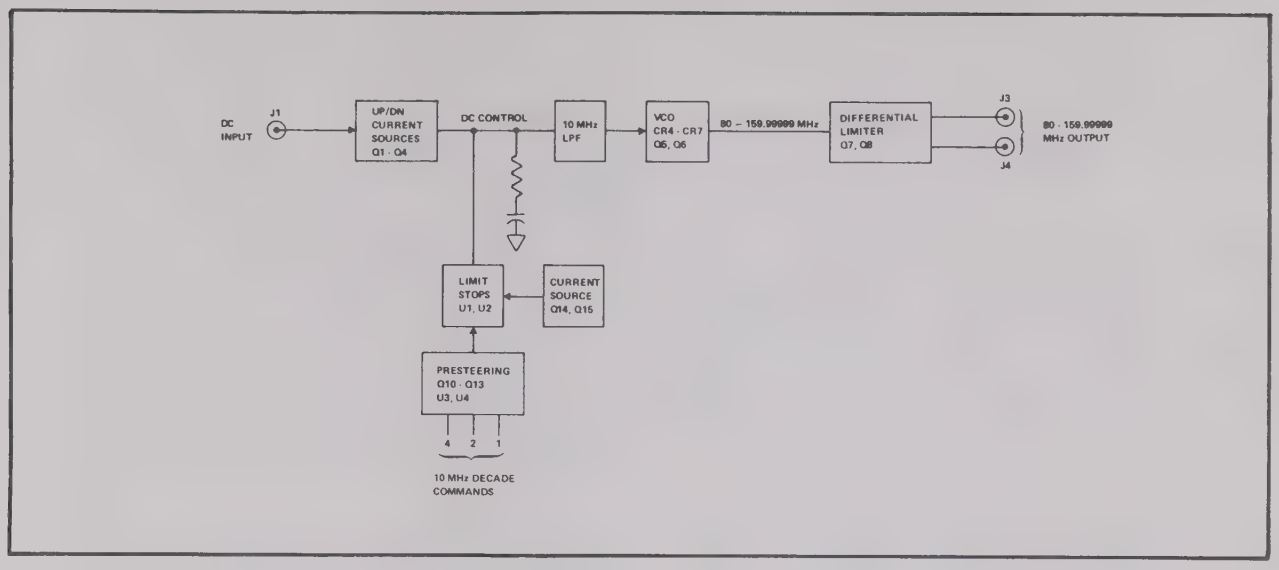



Figure 3-14. 10 MHz D. U. MAIN LOOP VCO MODULE BLOCK DIAGRAM

3-108. The VCO consisting of CR4 through CR7, Q6, Q7 and a printed circuit inductor produces an 80 to 159.99999 MHz signal dependent upon the dc control voltage across C6. Capacitance value of varicaps CR4 through CR7 depends upon the applied dc control voltage. These varicaps together with the tapped printed circuit inductor form a tuned circuit. Conduction of Q6 developes a signal which is coupled via C14 to the tuned circuit. Regenerative feedback to the base of Q6 via R15 sustains oscillations at the resonant frequency of the tuned circuit. Grounding of the emitter of Q6 is provided via the emitter-base junction of Q5. Transistor Q5 also buffers the resulting VCO output which is coupled via L8 and C18 to Q7 and Q8.

3-109. Transistors Q7 and Q8 form a differential limiter which translates the VCO signal to a symmetrical squarewave. Positive going inputs to Q7 cause it to conduct the maximum available current supplied via R24 and R25. Transistor Q8 is cut-off during this period and no output is developed at its collector. When the input to Q7 goes negative, Q7 is cut-off and Q8 conducts the maximum available current supplied via R24 and R25. The resulting squarewave signals developed across tapped inductors L9 and L10 are applied to J3 and J4.

## 3-110. Output Divider Module (6160A-4111)

3-111. The Output Divider Module (Drawing No. 6160A-1011) produces the final 1 to 160 MHz output of the synthesizer. It receives an 80 to 160 MHz input, band and range commands, and a dc level control voltage. The band and range commands select the appropriate dividers and filters which then produce an output signal proportional to the preselected dial settings or remote input. Amplitude of this output signal is dependent upon the level of a dc level control voltage. A block diagram of the circuitry is shown in Figure 3-15.

3-112. BUFFER LIMITER. The 80 to 160 MHz input at J4 is amplified by Q2 and limited by CR15 and CR16. Amplifier Q2 has a high forward rf gain controlled by feedback through C10, R94 and L29. Capacitor C95 couples the amplified signal to limiter, CR15 and CR16. The limiting point of CR15 and CR16 is set by voltages across CR17 and CR18. Diode CR17 is biased by R110 to +5V, while CR18 is self-biased to ground. The resulting limited 80 to 160 MHz signal is coupled through C124 to the 110 to 160 MHz and 80 to 110 MHz gates. It is also coupled through C94 to a 2/1 divider, U8.

3-113. RANGE AND BAND LOGIC. The range and band logic consists of NAND gates U1, U2, U9 and inverters Q1, Q3. This circuitry activates the appropriate dividers and filter/gates depending on range and band logic inputs. The range command is applied to U1 and Q1. It is a 0V command when the 1 - 12 MHz range is selected. When the 10 - 160 range is selected, this input is a +5V command. Band commands applied to U1A through U1D, U2A through U2D, and U9A, U9C correspond to the preselected output in the most significant decade (1 MHz or 10 MHz). A "1" in this decade produces the 1-2 band command; a "2" or "3" the 2-4 band command; a "4, 5, 6", or "7" the 4-8 band command; an "8" or above produces the 8-16 band command. The 80-110 band command is produced only in the 10 - 160 MHz range when an "8" to "10" exist in the 10 MHz decade.

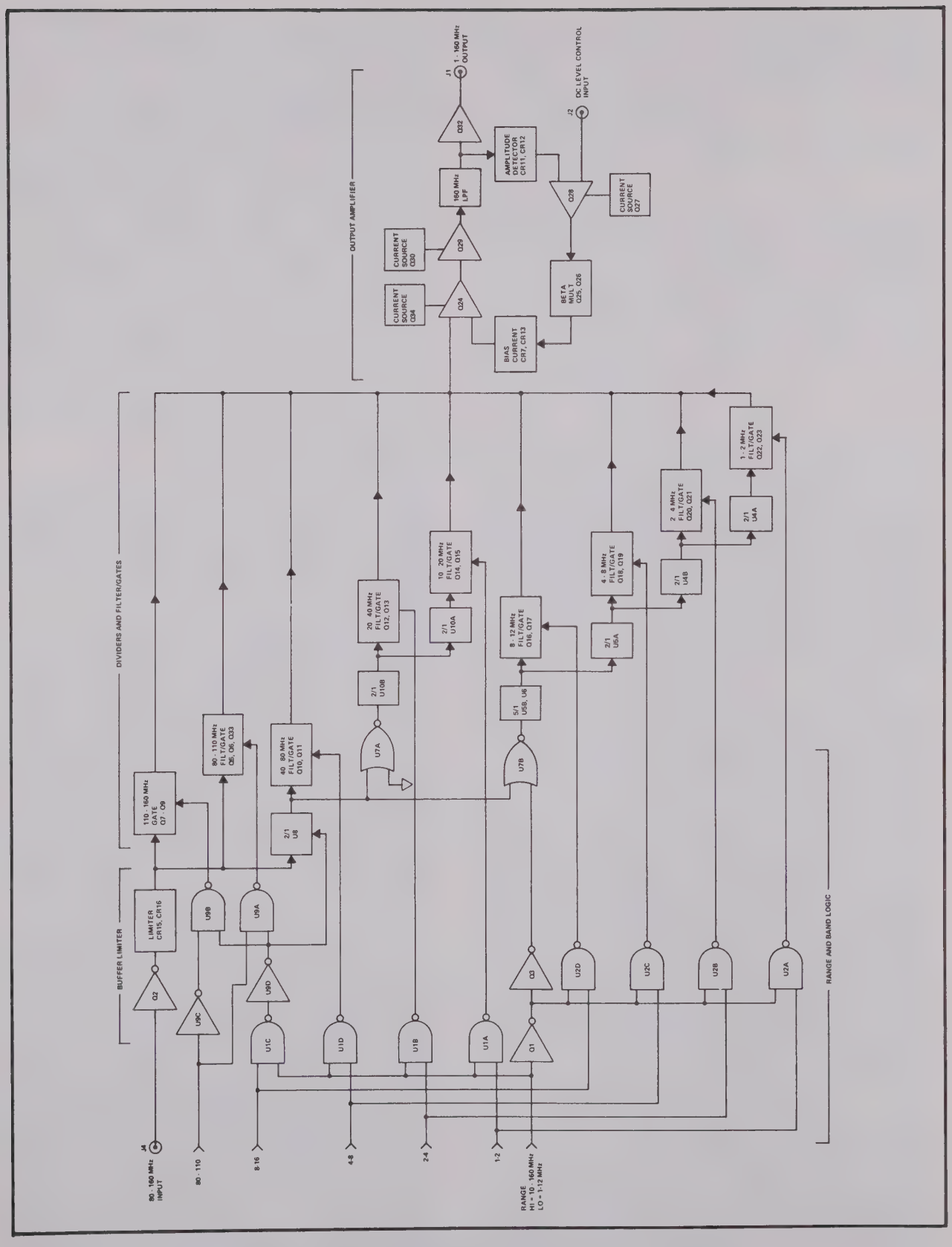



Figure 3-15. OUTPUT DIVIDER MODULE BLOCK DIAGRAM

3-114. Presence of a 10 - 160 MHz range command (+5V) will enable NAND gates U1A through U1D. Inverter Q1 conducts with this command present at its base and produces a 0V collector signal which disables NAND gates U2A through U2D. Transistor Q3 is switched on by conduction of Q1 and provides a +5V disable command to OR/NOR gate U7B. This disable command causes U7B to block the input signal to 5/1 divider U5B and U6. In the 1 - 12 MHz range, a 0V command is applied to the base of Q1. Subsequently, NAND gates U1A through U1D are disabled and Q1 is switched off. The resulting +5V collector signal of Q1 then enables NAND gates U2A through U2D. Transistor Q3 is switched off in conjunction with Q1 and enables OR/NOR gate U7B, which then passes the input signal to 5/1 divider U5B and U6.

3-115. Disabling of dividers not required to produce the preselected output is done in most cases by applying a +5V signal to the $\overline{K}$ or $C_1$ input of the divider. The only exception to this is the 5/1 divider U5B and U6 described previously and the 2/1 divider U10B. The input to U10B is supplied by OR/NOR gate U7A which is controlled by U1A or U1B.

3-116. Each divider is enabled by a 0V input applied to $\overline{K}$ or $C_1$ inputs. Divider U4A is enabled directly by a 0V output from U2A. Diodes CR1 and CR4 also enable dividers U4B and U5A in conjunction with U4A. Dividers U4B and U5A are separately enabled via CR2 and CR3 by a 0V output from U2B and U2C, respectively. The 0V output from U1A enables divider U10A directly. Diode CR5 enables divider U10B via OR/NOR gate U7A in conjunction with divider U10A. OR/NOR gate U7A is enabled separately via CR6 by a 0V output from U1B. Divider U8 is enabled by a 0V output of inverter U9D.

3-117. Band logic inputs to U1 and U2, in conjunction with the range command described previously, produce 0V outputs which also activate the associated 1 - 2 MHz through 40 - 80 MHz filter/gates. The 80 - 110 MHz filter/gate and 110 - 160 MHz filter/gate are activated via the combined action of U1C and U9. Presence of the 8-16 band command in the 10 - 160 MHz range produces a 0V output at pin 8 of U1C. The output of U1C is inverted by U9D and the resulting +5V signal applied to pin 2 of U9A, pin 4 of U9B, and pin 6 of U8. This signal is present at all times in the 10 - 160 MHz range. It functions as an enable input to NAND gates U9A and U9B and as a disable command for divider U8. Presence of an 80 - 110 band command provides a +5V input to pin 1 of U9A and pin 9 of inverter U9C. NAND gate U9A produces a 0V output which enables the 80 - 110 MHz filter/gate. The 110 - 160 MHz filter/gate is disabled by the corresponding +5V output of NAND gate U9B, which receives a 0V input at pin 5 via inverter U9C. If the 80 - 110 band command is not present, inverter U9C provides a +5V input to pin 5 of U9B. NAND gate U9B then produces a 0V output which enables the 110 - 160 MHz filter/gate. The 80 - 110 MHz filter/gate is disabled by the 5V output of NAND gate U9A.

3-118. DIVIDERS. There are seven series connected dividers in this module. Individual or group activation is done by appropriate range and band logic inputs, such that the 80 - 160 MHz input is divided down to yield the preselected output. Emitter-coupled logic is standard to provide a typical output signal swing of 0.8V. A high output is approximately +4.3V and a low +3.4V.

3-119. The limited 80 to 160 MHz signal coupled through C94 is divided down to 40 to 80 MHz by 2/1 divider U8. This divider is enabled by a 0V input to pin 6 from IC9D. A +5V input to pin 6 disables its operation. Voltage divider CR19, R16 and R17 provide proper bias at the pin 8 clock input. The resulting divided down 40 to 80 MHz outputs at pins 2 and 3 are coupled through C25 and C26 and applied to T3 via R18 and R19. Transformer T3 couples the signal to the following 40 to 80 MHz filter/gate. The divider output is also applied to OR/NOR gates U7A, U7B.

3-120. OR/NOR gate U7A is enabled by a 0V input to pin 4. When enabled, it applies the 40 to 80 MHz signal from U8 to pin 12 of 2/1 divider U10B. The resulting 20 to 40 MHz outputs at pins 9 and 15 are applied to T4 via R31 and R32. Transformer T4 couples the signal to the following 20 to 40 MHz filter/gate. The divider output at pin 9 is also applied to 2/1 divider U10A.

3-121. Divider U10A is enabled by a 0V input to pin 3. When enabled, it divides the 20 to 40 MHz input at pin 4 down to a 10 to 20 MHz signal available at pins 1 and 7. The 10 to 20 MHz output is applied to T5 via R30 and R54 and coupled to the following 10 to 20 MHz filter/gate.

3-122. OR/NOR gate U7B passes the 40 to 80 MHz output of U8 when a 0V input is applied to pin 10. The 5/1 divider consisting U5B, U6A and U6B divides the input down and produces an 8 to 16 MHz signal at pin 13 of U6B and pin 9 of U5B. The output at pin 2 of U6A is applied directly to the following 8 to 12 MHz filter/gate. The output at pin 9 of U5B is applied to 2/1 divider U5A.

3-123. Divider U5A is enabled by a 0V input to pin 3. When enabled, it divides down the 8 - 16 MHz input applied

to pin 4 and produces a 4 to 8 MHz signal at pins 1 and 7. The 4 to 8 MHz output is applied to T6 via R27 and R28 and coupled to the following 4 to 8 MHz filter/gate. The divider output at pin 7 is also applied to 2/1 divider U4B.

3-124. Divider U4B is enabled by a 0V input to pin 13. When enabled, it divides down the 4 to 8 MHz input applied to pin 12 and produces a 2 to 4 MHz signal at pins 9 and 15. The 2 to 4 MHz output is applied to T7 via R25 and R26 and coupled to the following 2 to 4 MHz filter/gate. The divider output at pin 15 is also applied to 2/1 divider U4A.

3-125. Divider U4A is enabled by a 0V input to pin 3. When enabled, it divides down the 2 to 4 MHz input applied to pin 4 and produces a 1 to 2 MHz signal at pins 1 and 7. The 1 to 2 MHz output is applied to T8 via R23 and R24 and coupled to the following 1 to 2 MHz filter/gate.

3-126. FILTER/GATES. The filter/gates pass or reject the 80 to 160 MHz input and the divider outputs depending on the range and band logic commands. The resulting filtered output of the activated filter/gate corresponds to the preselected frequency of the synthesizer.

3-127. Two types of filter/gates are used to pass the desired frequency: two transistor and three transistor. The two transistor filter/gates are used to pass or reject frequencies below 80 MHz. Frequencies above 80 MHz are passed or rejected by three transistor filter/gates. Since operation of each two transistor gate, except for 8 to 12 MHz filter/gate Q16, Q17, and three transistor filter/gates is similiar, only one of each type is described.

3-128. The two transistor 40 to 80 MHz filter/gate of Q10 and Q11 is activated by a 0V input to the base of Q10 via R39. Presence of this 0V input turns on Q10 and Q11 by providing a dc current path from +5V via R40, Q11, L4, L3, Q10 and R39 to the 0V output at pin 11 of U1D. Each transistor will saturate since their collector circuits are at a high impedance with no dc current path. The saturated transistors appear as a low impedance path to the 40 to 80 MHz signal coupled via T3, R103 and C27 to the collector of Q10. An 80 MHz low-pass filter consisting of C111 (traps C112, L3 and C43) L4, C29, and C30 rejects signal components above 80 MHz that are passed by Q10 and Q11. The filtered output is coupled by C106 to the output amplifier. Presence of a +5V output from U1D bias Q10 and Q11 off by disabling the base/emitter current path. The resulting high impedance collector/emitter path then prevents passage of the 40 to 80 MHz signal.

3-129. Filter/gate Q16 and Q17 operates in a manner similar to Q10 and Q11. Transistor Q16 is connected as an emitter-follower, and Q17 receives the turn on/off bias. Presence of a 0V input to the base of Q17 via R47 provides a dc current path from +5V via L36, Q16, R112, L9, L10, Q17 and R47. This dc current switches on Q16 and Q17 which then pass the 8 to 12 MHz signal to the output amplifier. The 12 MHz low-pass filter consisting of C109 (traps C110, L9 and C47) L10, and C48 rejects signal components above 12 MHz.

3-130. The three transistor 110 to 160 MHz filter/gate of Q7 through Q9 is activated by a 0V input to the base of Q8 via R37. Presence of this 0V input turns on Q7 through Q9 by providing a dc current path from +5V via R36, R38 and Q7, Q9, Q8, and R37 to the 0V output at pin 6 of U9B. Transistors Q7, Q9 and Q8 will saturate since their collector circuits are at a high impedance with no dc current path. The saturated transistors appear as a low impedance path to the 110 to 160 MHz input signal coupled by C21 to the collector of Q7. The signal passed by Q7 through Q9 is coupled via C108 to the output amplifier. Filtering for 110 to 160 MHz signals is done in the output amplifier.

3-131. OUTPUT AMPLIFIER. The output amplifier produces the final 1 to 160 MHz output having a level of +3 to +13 dbm into 50 ohms. Output amplitude is controlled by a dc control voltage. Transistor Q24 has a variable gain controlled by Q25, Q26 and Q28. Fixed gain is provided by Q29 and Q32. Transistors Q34, Q30 and Q31 provide a fixed dc current for Q24, Q29, and Q32, respectively.

3-132. The 1 to 160 MHz signal is first amplified by variable gain amplifier Q24. Negative feedback through L18, R58 and C68 provides gain flatness over the entire frequency range. A constant dc current through Q24 is provided by Q34 which maintains a constant voltage across R60. Variable gain is controlled by CR7 and CR13 which act as current variable resistors. These diodes are controlled by Q25, Q26 described later. The amplified collector signal of Q24 is coupled through C73 and further amplified by fixed gain amplifier Q29. A constant dc current through Q29 is provided by Q30 which maintains a constant voltage across R73. Negative feedback through L20, R69 and C75 provides gain flatness. Capacitor C82 couples the amplified output from Q29 to the 160 MHz low-pass filter composed of C87, C88, C91, C90, L24 and C77. This filter rejects signal components above 160 MHz. The resulting filtered signal is then amplified by Q32 and applied to J1. Constant dc current through Q32 is provided by Q31 which maintains a constant voltage across R86. Negative feedback through R90, R92 and C84 provides gain flatness.

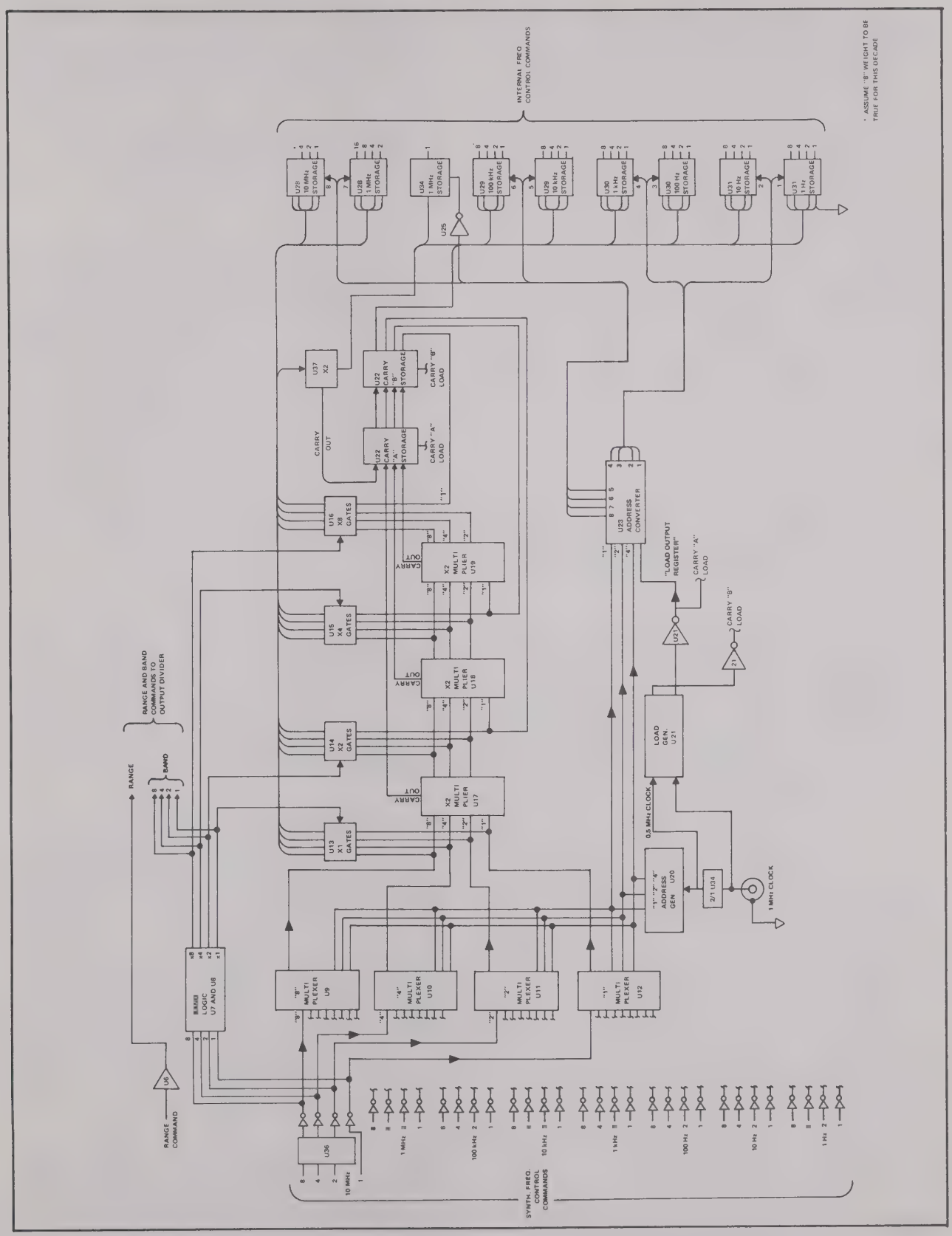



Figure 3-16. COMPUTER ASSEMBLY BLOCK DIAGRAM

3-133. The filtered output signal is also coupled via R82 and C81 to amplitude detector CR11 and CR12. The detector output developed across C80 is a dc voltage proportional to the amplitude of the rf output. This dc voltage is applied to one input of differential amplifier Q28 which receives a variable dc control at its other input from J2. The variable dc control voltage is derived from the front panel LEVEL control or an external source via the rear panel. Differential amplifier Q28 compares its two inputs and produces a difference output which is applied to Q26. Transistor Q27 provides a constant current for Q28. The difference output from Q28 is amplified by Q26 and Q25 which control the gain of Q24. Any difference in the detected output level and the dc control voltage subsequently alters the gain of Q24 until both inputs to Q28 are equal. As a result, the output level is maintained to nominally ±1 db of the preset level over the 1 to 160 MHz range.

## 3-134. Computer Assembly (6160B-4012)

3-135. The Computer Assembly (Drawing No. 6160B-1012) receives manual or remote synthesizer frequency control commands and converts them to internal frequency control commands. A block diagram of the circuitry is shown in Figure 3-16.

3-136. Manual commands from the front panel switches are introduced through J3 and J4. Selection of local command is accomplished by disconnecting power to gates U1 through U5 and grounding the common frequency selector switch bus on the front panel. This is accomplished by setting the front panel FUNCTION switch to the 1 - 12 MHz or 10 - 160 MHz position.

3-137. Remote commands arrive through J16. Setting the front panel FUNCTION switch to REMOTE applies power to gates U1 through U5. The common frequency selector bus on the front panel is ungrounded, thereby preventing the outputs of gates U1 through U5 from being pulled low (0V) through the front panel switches. Resistors R1 through R31 provide multiplexer input current when the multiplexer inputs are in a high (+5V) state. U36 combines the BCD bits of the 10 MHz decade with the 1 bit of the 100 MHz decade to provide a binary coded 10 MHz digit with legitimate states of 1 through 15. Inverters U6C and U6F control the remote range. The outputs of gates U1 through U5C are applied to the 1, 2, 4, and 8 multiplexers U9 through U12. The output of gates U5D, U5E, U6A and U6B is applied to the band logic circuitry.

3-138. BAND LOGIC. The Band Logic circuitry consists of inverters U7 and NAND gates U8 and U33. The band logic decodes the 10 MHz digit information and selects the appropriate x1, x2, x4, or x8 gates. NAND gate U8-12 and inverter U7-12 decode the 1 - 2 band command. NAND gate U8-6 and inverters U7-10 and U7-2 decode the 2 - 4 band command. NAND gate U8-8 and inverters U7-4 and U7-8 decode the 4 - 8 band command. Inverter U7-6 supplies the 8 - 16 band command. The logic at inverters U7 is also applied to the x1, x2, x4 and x8 gates.

3-139. CLOCK AND LOAD GENERATOR. The Clock and Load Generator circuitry consists of NAND gates U35-11, U35-3, U35-8, NOR gates U21-1 through -13, and load generator U34. A 1 MHz clock signal is applied to NAND gates U35-11, -3, and -8. After inversion, the signal the signal is applied to a binary circuit within U20. The output of this binary circuit, pin 1, is then applied to the load generator U34 and NAND gates U21-10 and U21-13. The load generator is also driven by the 1 MHz output of NAND gate U35-8. The outputs of U20 and U34 are gated together with NAND gates U21-1, U21-10, and U21-13 to produce 4 discrete phases of the 500 kHz clock. Figure 3-17 shows the waveshapes of this circuitry.

3-140. MULTIPLEXERS. The Multiplexer circuitry sequentially presents decade bit information of the 1, 10, 100 Hz, kHz, and 1 and 10 MHz decades to the x2, Multiplier and x1 gate circuitry. The multiplexing is done under command of the address generator U20. The multiplexer circuitry consists of multiplexers U9 through U12. U9 is the "8" multiplexer, U10 the "4" multiplexer, while U11 is the "2" multiplexer and U12 the "1" multiplexer.

3-141. X2 MULTIPLIERS. The X2 Multiplier circuitry consists of U17, U18, and U19. The first x2 Multiplier, U17, receives the serial input from multiplexers U9 through U12 and multiplies that input by a factor of two. The second multiplier U18 multiplies the output of the first multiplier by a factor of two, thereby achieving a total multiplication of four. U19, the third multiplier multiplies the output of the second multiplier by a factor of two, thereby achieving a total multiplication of eight. The 2, 4, and 8 output lines of the multipliers command the x2, x4, and x8 gates while the 1 line is fed to the Carry Storage Circuit U22. Table 3-1 shows input/output logic for any given multiplier.

3-142. X1, X2, X4, X8 GATES. The Multiplier Gates, NAND gates U13 through U16, select the desired multiplier output (x1, x2, x4, or x8) to be loaded into the storage circuitry. Selection of the appropriate gate is ac-

complished by command signals from the band logic circuitry. Inverter U25 inverts the selected gate output and applies the time multiplexed command to the input of the storage registers U28 and U37.

Table 3-1. X2 MULTIPLIER INPUT/OUTPUT LOGIC

| | INPUT | | | | | OUTPUT | | | |
|---|---|---|---|---|---|---|---|---|---|
| COM-MAND | 1 1 | 2 16 | 4 15 | 8 10 | BIT PIN | *3 | 2 5 | 4 4 | 8 4 |
| 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | | 0 | 1 | 0 | 0 |
| 2 | 0 | 1 | 0 | 0 | | 0 | 0 | 1 | 0 |
| 3 | 1 | 1 | 0 | 0 | | 0 | 1 | 1 | 0 |
| 4 | 0 | 0 | 1 | 0 | | 0 | 0 | 0 | 1 |
| 5 | 1 | 0 | 1 | 0 | | 1 | 0 | 0 | 0 |
| 6 | 0 | 1 | 1 | 0 | | 1 | 1 | 0 | 0 |
| 7 | 1 | 1 | 1 | 0 | | 1 | 0 | 1 | 0 |
| 8 | 0 | 0 | 0 | 1 | | 1 | 1 | 1 | 0 |
| 9 | 1 | 0 | 0 | 1 | | 1 | 0 | 0 | 1 |

* Carry Output

3-143. CARRY STORAGE. The Carry Storage Circuitry, U22, is broken into two separate functions labeled carry storage A and carry storage B. During phase C of the clock period, carry storage A is loaded to store any multiplier carry outputs. At phase A of the following 500 kHz clock cycle, the contents of carry storage A is transfered into carry storage B to become the 1 bit input to the succeeding multiplier. NAND gates U33-3, U33-8, and U33-11 supply overriding commands to the 1, 2, and 4 multiplexers to prevent carry bits from being transfered from the 10 MHz decade to the 1 Hz decade at the end of each sweep through the decades.

3-144. ADDRESS CONVERTER. The Address Converter, U23, converts the 3 bit address code generated by the address generator, U20, into 8 discrete outputs. Inverters U24 and U25 invert the outputs of U20 and sequentially command the proper storage register for loading.

3-145. STORAGE REGISTER. The Storage Register circuitry consists of U28 through U31, each being a dual quad latch. Storage information is received through the x1, x2, x4, and x8 gates. The proper storage register to be loaded is commanded by the address converter. The output lines of the storage registers are applied to either J5 or J7. NAND gate U32 generates the 80 - 110 command command utilized in the Output Divider Module (6160A-4111).

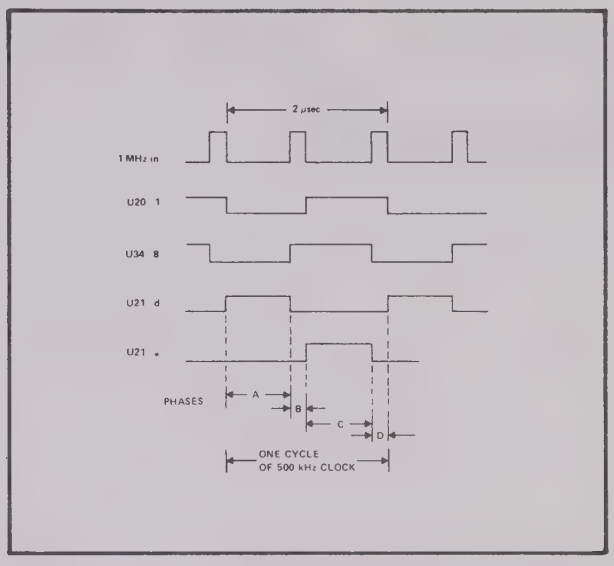



Figure 3-17. CLOCK AND LOAD GENERATOR WAVESHAPES.

3-146. X2 MULTIPLIER. U37 multiplies the inputs to U29, U30, and U31. Carry outputs of U37 are stored in carry storage A and B, as described in paragraph 3-143. These become the "1" bit input to succeeding digits. The carry output of the 100 kHz digit is sotred in U34 to become the 1 MHz bit to the 1 MHz Digit Generator. The "1" bit of the 1 Hz storage is wired to "0" to prevent loading of 10 MHz carries in the 1 Hz digit.

# Section 4
# Maintenance

## 4-1. INTRODUCTION

4-2. This section contains information and instructions concerning preventive and corrective maintenance for the Model 6160B Frequency Synthesizer. The information and instructions are arranged under headings of "SERVICE INFORMATION, MAINTENANCE ACCESS, GENERAL MAINTENANCE, OPERATIONAL CHECK AND ADJUSTMENT, MODULE ALIGNMENT, and TROUBLESHOOTING.

4-3. A list of test equipment required to service the synthesizer is contained in Table 4-1. If the recommended equipment is not available, other equipment having equivalent specifications may be used.

## 4-4. SERVICE INFORMATION

4-5. Each synthesizer that is manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of one year upon delivery to the original purchaser. The WARRANTY is located at the front of the manual.

4-6. Factory authorized calibration and service for each Fluke product is available at various world-wide locations. A complete list of these authorized service centers is located at the rear of the manual. Shipping information is given in Section 2, paragraph 2-3. If requested, an estimate will be provided to the customer before any repair work is begun on instruments that are beyond the warranty period.

Table 4-1. REQUIRED TEST EQUIPMENT

| EQUIPMENT NOMENCLATURE | RECOMMENDED EQUIPMENT |
|---|---|
| Frequency Counter | Fluke Model1952A 079 |
| RF Voltmeter | H. P. Model 411 |
| Oscilloscope | Tektronix Model 454 |
| Spectrum Analyzer | H. P. Model 8551B/851B |
| Loads | 50Ω, @12W, 2.2k, @15W, 1k, 33k, 39k, 3M, 3.3M, 130Ω, @¼W |
| Digital Voltmeter | Fluke Model 8200A |
| DC Voltage Calibrator | Fluke Model 341A |
| Power Supplies:<br>+5V dc, +14V dc<br>−12V dc | <br>Harrison Lab, Model 865B<br>Acoptan Model LL |
| 120 db, 10 db Step Attenuator | H.P. Model 355D |
| Signal Generators:<br>50 kHz - 65 MHz<br>10 MHz - 480 MHz | <br>H.P. Model 606<br>H.P. Model 608C (2) |
| Splitter, 6 db | Three 50 ohm resistors in delta configuration |
| Multimeter | Fluke Model 8000A |

## 4-7. MAINTENANCE ACCESS

### 4-8. Major Section Access

4-9. To gain access to the major sections of the synthesizer, proceed as follows:

a. Turn off the SYNTHESIZER and disconnect the power cord.

b. Set the synthesizer on its left side

*NOTE!*

*If the synthesizer is rack mounted, slide it out until the chassis slides lock in the extended position.*

c. Remove the top and bottom dust covers. Access is now provided to the modules shown in Figure 4-1.

d. Remove the output divider. Access is now provided to the plug-in assembly.

### 4-10. Module Removal

4-11. To remove a module, proceed as follows:

a. Disconnect cabling and wiring.

b. Remove screws securing module and remove the module from synthesizer.

*NOTE!*

*When reassembling module into synthesizer, refer to Figure 4-2 for wiring connections. Refer to Block Diagram 6160B-1501 for cabling connections. When attaching cabling to modules, carefully align cable connector and mating connector on module before plugging together.*

### 4-12. Plug-in Printed Circuit Card Removal

4-13. Only one plug-in pcb assembly, Power Supply Regulator, is in the synthesizer. It is located under the Output Divider module. Access and removal of the pcb card is as follows:

a. Gain access to pcb by removing Output Divider module, see Figure 4-1 for location.

b. Remove plug-in board by using a constant lifting force accompanied by a gentle rocking motion.

*NOTE!*

*A riser card for servicing is installed beside the pcb assembly.*

### 4-14. Hinged Printed Circuit Assembly Access

4-15. To service the hinged printed circuit assemblies, proceed as follows:

a. Remove retaining (at rear-panel end of assembly) screws which hold the assembly in place.

b. List the assembly away from the synthesizer until the hinge locking bracket snaps in the locked or extended position.

### 4-16. Front Panel PCB Access

4-17. To service the front panel printed circuit assembly, proceed as follows:

a. Disconnect cabling from front panel printed circuit assembly to computer board at the computer board.

b. Remove decals from corner handle sides.

c. Remove four (4) screws from each corner handle side.

d. Disconnect RF OUTPUT cable from inside connection.

e. Pull front panel assembly away from chassis.

f. Remove knobs from front panel.

g. Disconnect indicator leads from front panel printed circuit assembly.

h. Remove five (5) mounting nuts from the rear of the front panel PCB assembly.

i. Pull front panel away from front panel PCB assembly. (Switch mounting bracket will remain with PCB).

j. Remove switch mounting nuts from front of switch mounting bracket and separate bracket from PCB. Access is now gained to service the switch assembly.

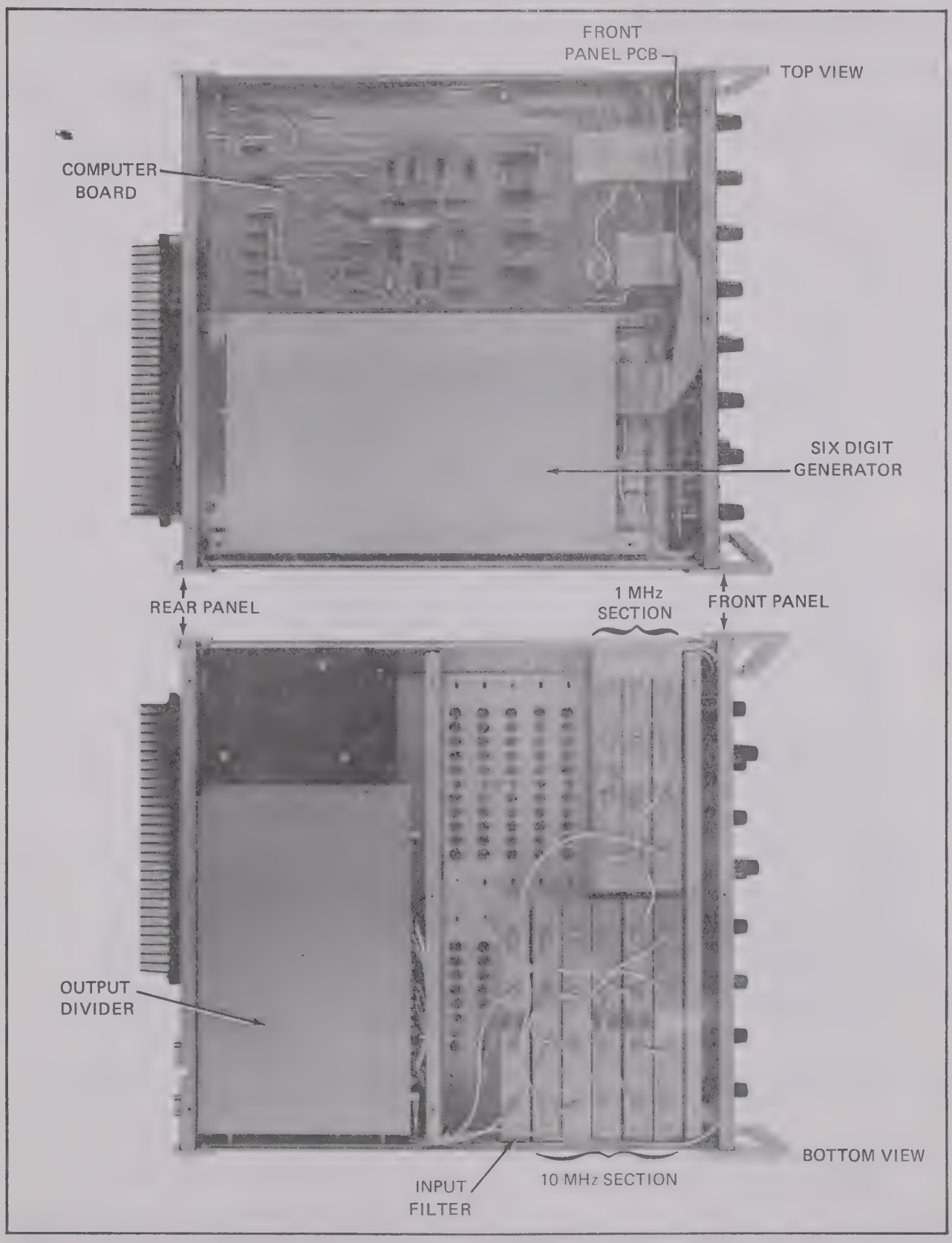



Figure 4-1. SECTION LOCATIONS

## 4-18. GENERAL MAINTENANCE

### 4-19. Cleaning

4-20. Clean the instrument periodically to remove dust, grease, and other contamination. Use the following procedure:

a. Clean the interior with clean, dry air at low pressure. When the printed circuit boards require cleaning, first spray them with Freon T.F. Degreaser (Miller Stephensen Company, Inc.) and then remove the dirt with clean, dry air at low pressure.

b. Clean the front panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened in a mild solution of detergent and water.

### 4-21. Fuse Replacement

4-22. There are two fuses located in bayonet fuseholders on the rear panel. These fuses protect the ac power circuitry from overloads. When replacing these fuses, use 1.5A Slo-Blo for 115 Vac line power.

### 4-23. Lamp Replacement

4-24. The decimal, POWER, and INVALID FREQuency indicators are located on the front panel and can be removed without any special tools. To remove these indicators, proceed as follows:

a. Remove top and bottom covers.

b. Disconnect leads from defective indicator to switch pcb.

c. Push bushing and defective indicator out of front panel by applying pressure from inside the front panel.

d. Remove thermofit sleeving and desolder connections from indicator to connector leads.

e. Replace defective indicator with Fairchild VLV 102, John Fluke Part No. 309617.

f. Install indicator using the preceeding procedure in reverse.

## 4-25. OPERATIONAL CHECKS AND ADJUSTMENTS

4-26. The following procedure checks the overall operation of the frequency synthesizer. It also includes minor adjustments for power supplies and RF output level. This procedure should be used after corrective maintenance has been performed. The following test equipment will be required:

a. Digital Voltmeter

b. RF Voltmeter with compensated in-line 50 ohm load.

c. Frequency Counter

d. Variable DC Voltage Source

e. 50 ohm coax. cable for counter

f. 50 ohm resistive load

### 4-27. Front Panel

a. Set controls as follows:

| | |
|---|---|
| FUNCTION Switch | OFF |
| 10 MHz Frequency Dial | 15 |
| OUTPUT LEVEL Control | +13 dBm |
| LEVEL CONT (rear panel) | INT |

b. Terminate RF OUTPUT connector with 50 ohm load.

c. Connect a 5 MHz frequency standard to 5 MHz INPUT CONNECTOR, J2, on rear panel.

*NOTE!*

*If –02 or –05 internal frequency standard options are installed, connect the STD OUTPUT (J1) connector to 5 MHz INPUT (J2) connector with the patch cable provided.*

d. Connect line cord to power source.

e. Turn FUNCTION switch to 1–12 MHz position and verify that POWER indicator, INVALID FREQ indicator, and left decimal indicator illuminate.

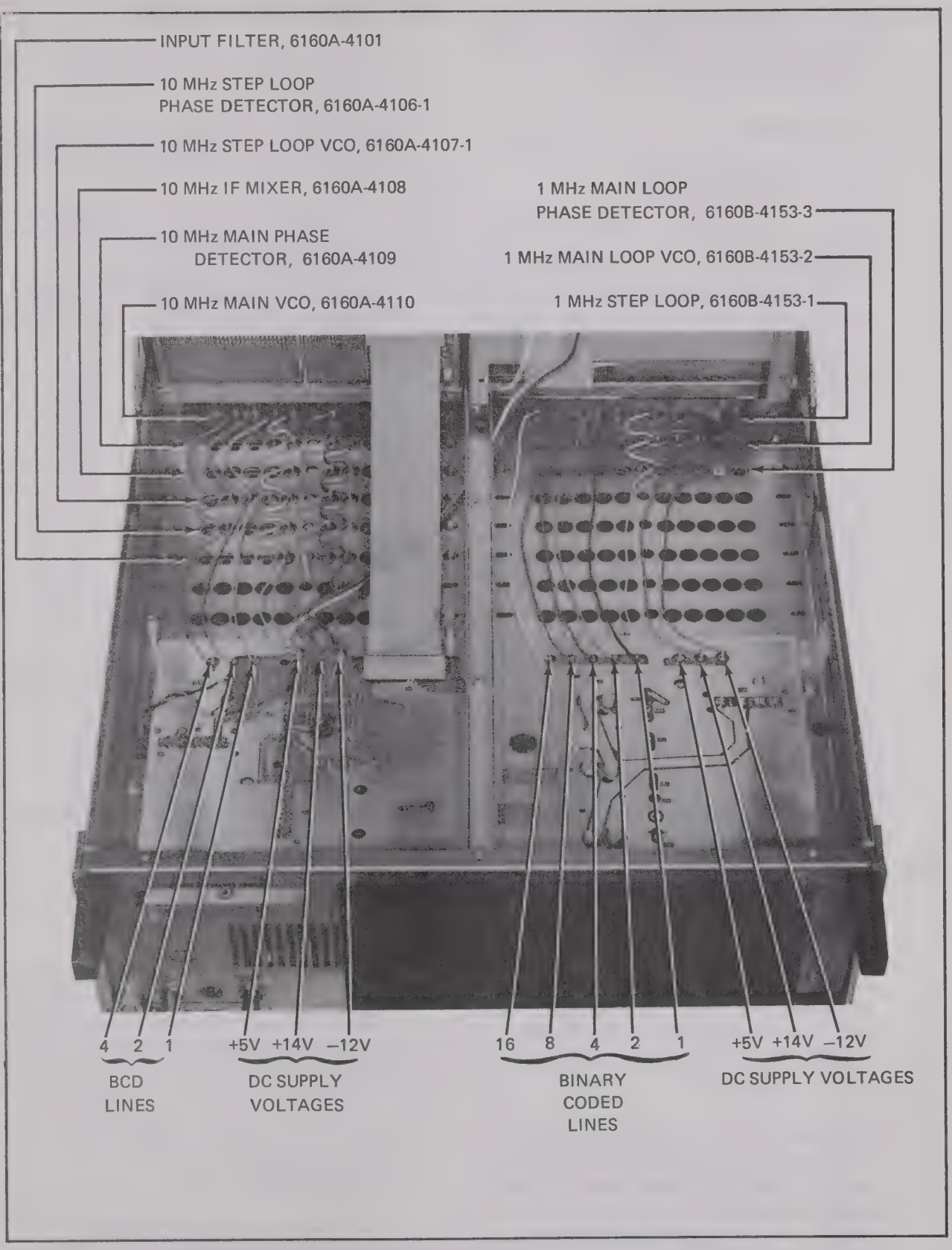

INPUT FILTER, 6160A-4101
10 MHz STEP LOOP PHASE DETECTOR, 6160A-4106-1
10 MHz STEP LOOP VCO, 6160A-4107-1
10 MHz IF MIXER, 6160A-4108
10 MHz MAIN PHASE DETECTOR, 6160A-4109
10 MHz MAIN VCO, 6160A-4110
1 MHz MAIN LOOP PHASE DETECTOR, 6160B-4153-3
1 MHz MAIN LOOP VCO, 6160B-4153-2
1 MHz STEP LOOP, 6160B-4153-1
4 2 1
+5V +14V –12V
16 8 4 2 1
+5V +14V –12V
BCD LINES
DC SUPPLY VOLTAGES
BINARY CODED LINES
DC SUPPLY VOLTAGES

Figure 4-2. MODULE WIRING CONNECTIONS

f. Turn FUNCTION switch to 10–160 MHz and check that INVALID FREQ indicator and left decimal indicator are extinguished, but right decimal indicator illuminates.

## 4-28. Power Supplies

a. Remove top cover of instrument.

b. Remove five screws securing Computer Board and tilt board up to allow access to module tray and Mother Board PCB.

c. Refer to Figure 4-3 and connect DVM between synthesizer chassis and –12V connector on the 10 MHz Step Loop module, 6160A-4107-1. DVM should indicate –12 Vdc ±3 mV. Adjust R40 if necessary (See Figure 4-3 for location).

d. Refer to Figure 4-3 and connect DVM between chassis and +14V connector on 10 MHz Step Loop module, 6160A-4107-1. DVM should indicate +14 Vdc ±3 mV. Adjust R21 if necessary (See Figure 4-3 for location).

e. Refer to Figure 4-3 and connect DVM between chassis and +5V connector on 10 MHz Step Loop module, 6160A-4107-1. Check DVM indication to be +5 Vdc ±15 mV.

f. Disconnect DVM and secure computer board to chassis. Install top cover on instrument.

## 4-29. Local Frequency Control

a. Connect frequency counter through 50 ohm coax cable to RF OUTPUT. Terminate cable with 50 ohm load at counter input. Gate counter with signal derived from synthesizer's frequency standard. (For synthesizers with –02 or –05 Options installed, obtain gate signal from BUFF 5 MHz OUTPUT on rear panel.

b. Set frequency dials to frequencies listed in Table 4-2. Output frequency should be ±1 count, for counter ambiguity, from dialed frequency. (These particular frequencies are not random but are chosen to exercise all digital commands from the computer for each decade.)

## 4-30. Remote Frequency Control

a. Set FUNCTION switch to REMOTE FREQ CONTROL.

b. Connect remote programming source to REMOTE FREQUENCY CONTROL connector on rear panel.

c. Program frequencies listed in Table 4-2. Output should be ±1 count from programmed frequency.

Table 4-2. FREQUENCY CONTROL CHECK POINTS

| RANGE | FREQUENCY | RANGE | FREQUENCY |
|---|---|---|---|
| 10-160 MHz | 80,000000 | 10-160 MHz | 40.875000 |
| | 81.111111 | | 80.650000 |
| | 82.222222 | | 20.650000 |
| | 93.333333 | | 19.500000 |
| | 104.444444 | | 39.500000 |
| | 115.555555 | | 79.500000 |
| | 126.666666 | | 42.250000 |
| | 137.777777 | | 125.250000 |
| | 148.888888 | 1-12 MHz | 1.9990000 |
| | 159.999999 | | 3.9990000 |
| | 10.875000 | | 7.9247500 |
| | 30.875000 | | 8.0004997 |

d. Disconnect remote programming source from synthesizer and set FUNCTION switch to 10-160MHz LOCAL FREQ CONTROL.

## 4-31. 5 MHz Output

a. Connect rf voltmeter through 50 ohm in-line load to BUFF 5 MHz OUTPUT (J4).

b. Indication on rf voltmeter should be +13 dBm ±2 dB.

c. Remove rf voltmeter. Connect frequency counter through 50 ohm coax cable to the BUFF 5 MHz OUTPUT (J4). Counter input should be terminated with 50 ohm load. Gate counter with signal derived from synthesizer's frequency standard.

d. Counter should indicate 5 MHz ±0.1 Hz.

e. Remove counter.

f. If –02 Option is installed, perform step g. If –05 Option is installed, perform step h.

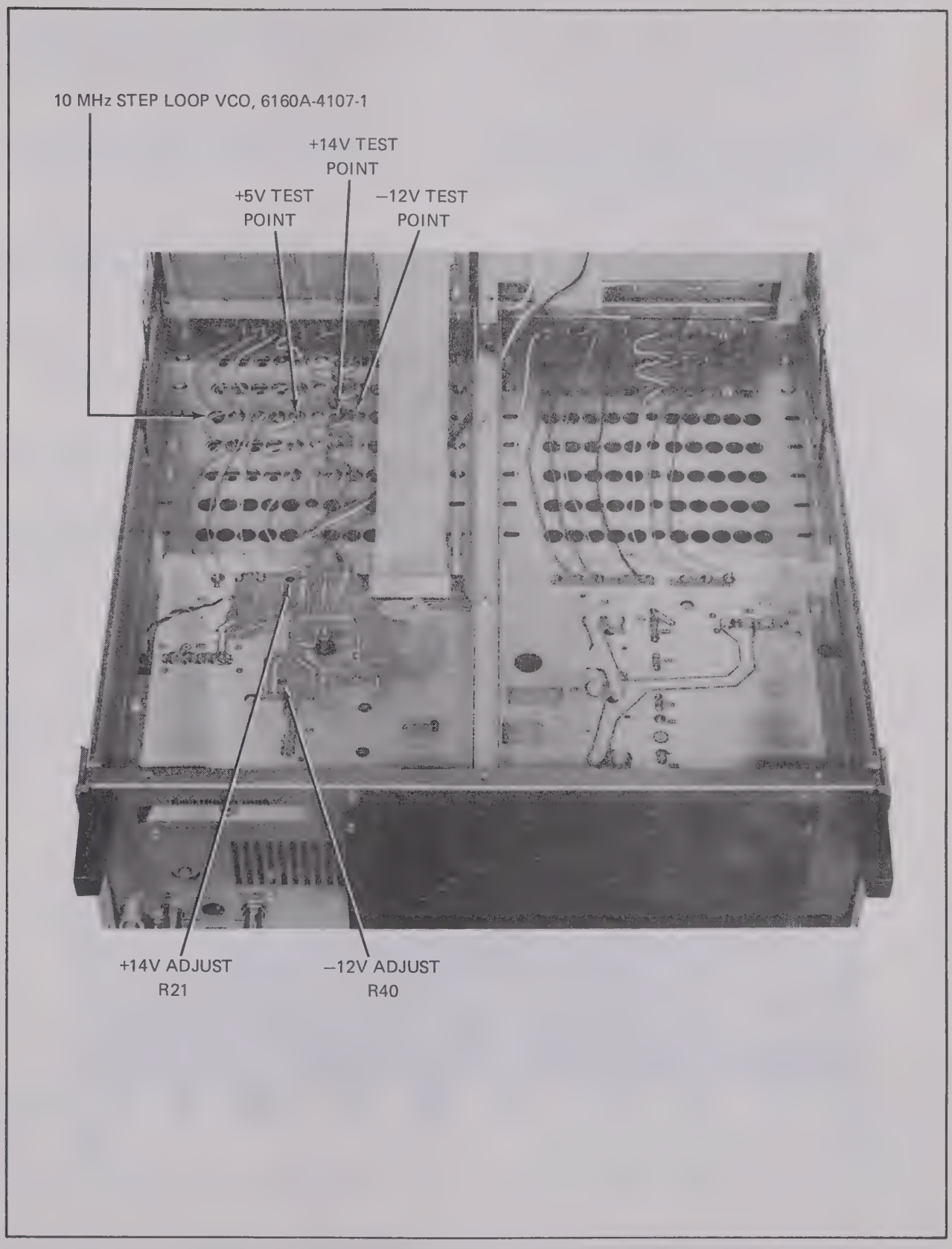



Figure 4-3. POWER SUPPLY TEST POINTS AND ADJUSTMENTS.

g. Connect rf voltmeter through 50 ohm in-line load to STD OUT (J1). Output level of –02 Option is 13 dBm ±2 dB.

h. Connect BNC "T" to 5 MHz INPUT (J2), Jumper STD OUT (J1) to one side of BNC "T". Connect RF Voltmeter to other side of BNC "T". Output level for the –05 Option is +4 dBm ±2 dB.

i. Disconnect rf voltmeter and BNC "T".

## 4-32. RF Output Level

a. Connect rf voltmeter through 50 ohm in-line load to RF OUTPUT connector on front panel.

b. Set OUTPUT LEVEL control to +13 dBm position.

c. Rotate highest frequency dial through positions 1 to 15 and observe that indication on rf voltmeter is +13 dBm ±1 dB. If necessary, adjust R4 (refer to Figure 4-4 for location).

d. Set FUNCTION switch to 1–12 MHz and repeat Step c, but rotate frequency dial through positions 1 to 12.

e. Set OUTPUT LEVEL control to +3 dBm position.

f. Rotate highest frequency dial through positions 1 to 12 and observe that rf voltmeter indicates +3 dBm ±1 dB. If necessary, adjust R6 (refer to Figure 4-4 for location).

g. Set FUNCTION switch to 10-160 MHz and repeat Step f, but rotate frequency dial through positions 1 to 15.

h. If necessary repeat steps b through g until output levels at +3 dBm and +13 dBm are flat to ±1 dB throughout the frequency range dialed.

i. Disconnect rf voltmeter. Install bottom cover and set synthesizer in upright position.

## 4-33. External Level Control

a. Set LEVEL CONT switch on rear panel to EXT position.

b. Connect rf voltmeter through 50 ohm in-line load to RF OUTPUT connector on front panel.

c. Set frequency dials to 40 MHz.

d. Connect variable dc voltage source to LEVEL CONT INPUT connector on rear panel.

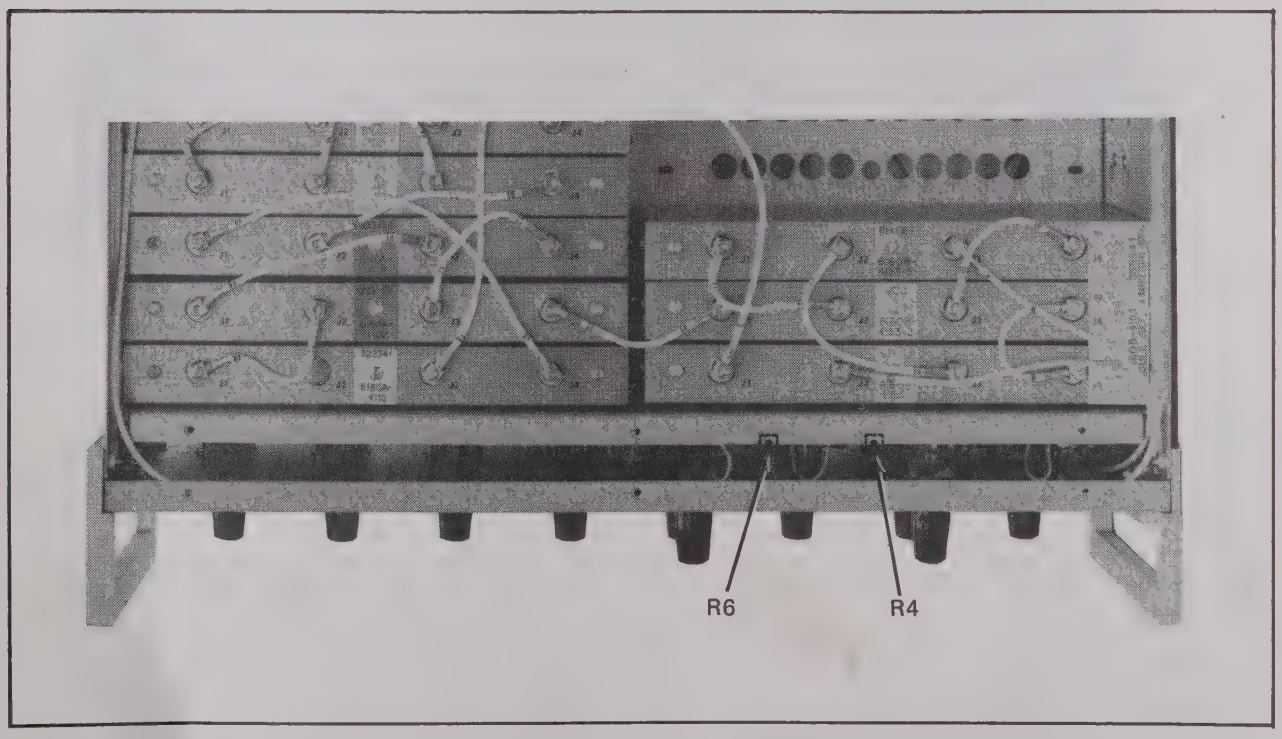



Figure 4-4. OUTPUT LEVEL ADJUSTMENTS

e. Adjust dc voltage source until rf voltmeter indicates +5 dBm. Output of voltage source should be 325 mVdc ±50 mV.

f. Increase dc voltage source output until rf voltmeter indicates +10 dBm. Output of voltage source should be 525 mVdc ±50 mV.

g. Increase voltage source output until rf voltmeter indicates +13 dBm. Output of voltage source should be 725 mVdc ±50 mV.

h. Disconnect all test equipment and set LEVEL CONT switch to INT.

## 4-34. MODULE ALIGNMENT

4-35. The Model 6160B modules were completely aligned and tested before leaving the factory. They should not require realignment unless corrective maintenance is performed. Realignment or testing should be necessary only on the module or modules which have been repaired.

4-36. Test equipment required to align or test the modules is listed at the beginning of each procedure. A composite listing of recommended test equipment is listed in Table 4-1. Adjustment and test point locations are shown in illustrations included with each procedure.

*NOTE!*

*A service kit (6160A-7006), JF part number 339002, is available for use in alignment or troubleshooting the Model 6160B.*

### 4-37. Alignment or Test Signals

4-38. Module alignment or testing requires input power of +5, +14, and −12 V dc, in addition to specific rf signals. These inputs can be obtained from the test equipment listed in Table 4-1 or directly from the synthesizer.

### 4-39. Power Supply Regulator Assembly (6160A-4014)

4-40. Alignment of this assembly is done in the synthesizer using the following equipment.

a. Digital Voltmeter

b. Resistor, 100Ω, 2W, ± 10% (JF part number 109934).

4-41. Align the assembly using the following procedure. Test point and adjustment locations are shown in Figure 4-5.

a. Disconnect power and remove the five screws securing the computer PCB assembly. Lift the assembly until the hinge locks.

b. Connect a digital voltmeter between the −12V terminal on the Motherboard and chassis.

c. Program power on and set −12V adjust for a −12.000V indication on voltmeter.

d. Touch the 100 ohm 2 watt resistor between the ground plane on the Motherboard and −12V terminal. Voltmeter indication should not change more than 1 mV.

e. Remove the resistor and connect the voltmeter between the +14V terminal and chassis.

f. Set the +14V Adjust for a +14.000V indication on the voltmeter.

g. Touch the 100 ohm resistor between the pcb ground plane and the +14V terminal. Indication on the voltmeter should not change more than 1 mV.

h. Remove resistor and connect voltmeter between the +5V terminal and chassis.

i. Jumper the +14V CONT and −12V CONT to chassis (See Figure 4-17)

j. Voltmeter should indicate +5V ± 20 mV. Note reading.

k. Disconnect interface cable at J8 on Motherboard and note voltmeter indication. Difference between this reading and reading noted in step j should be less than 2 mV.

l. Reconnect cable to J8. Remove jumpers and test equipment.

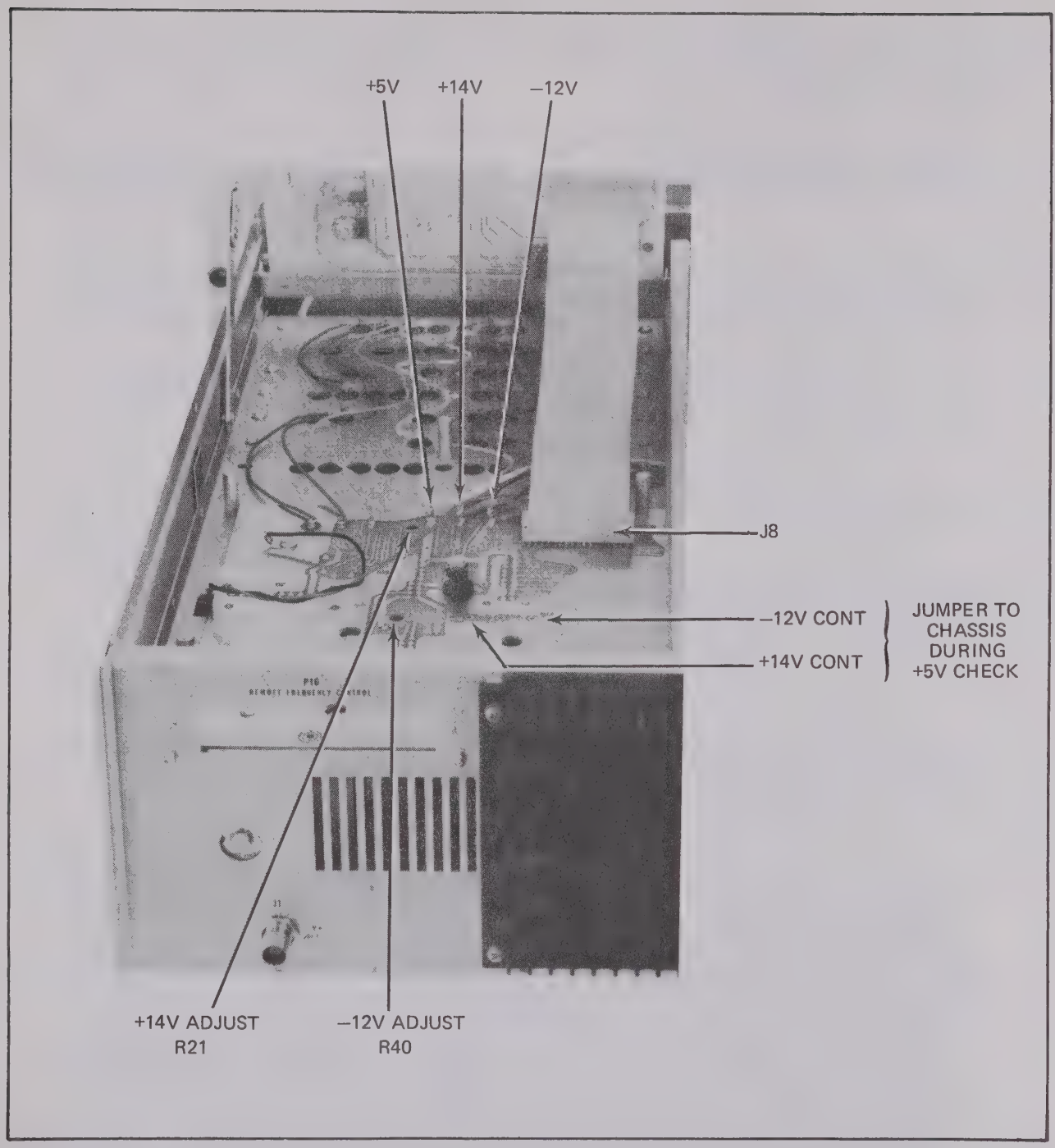



Figure 4-5. POWER SUPPLY REGULATOR ADJUSTMENT AND TEST POINT LOCATIONS

## 4-42. Input Filter (6160A-4101)

4-43. This module is removed from the synthesizer and aligned with the following equipment:

a. Power Supply

b. Oscilloscope

c. RF Voltmeter

d. 50 ohm load

e. Signal Generator (or internal standard if installed).

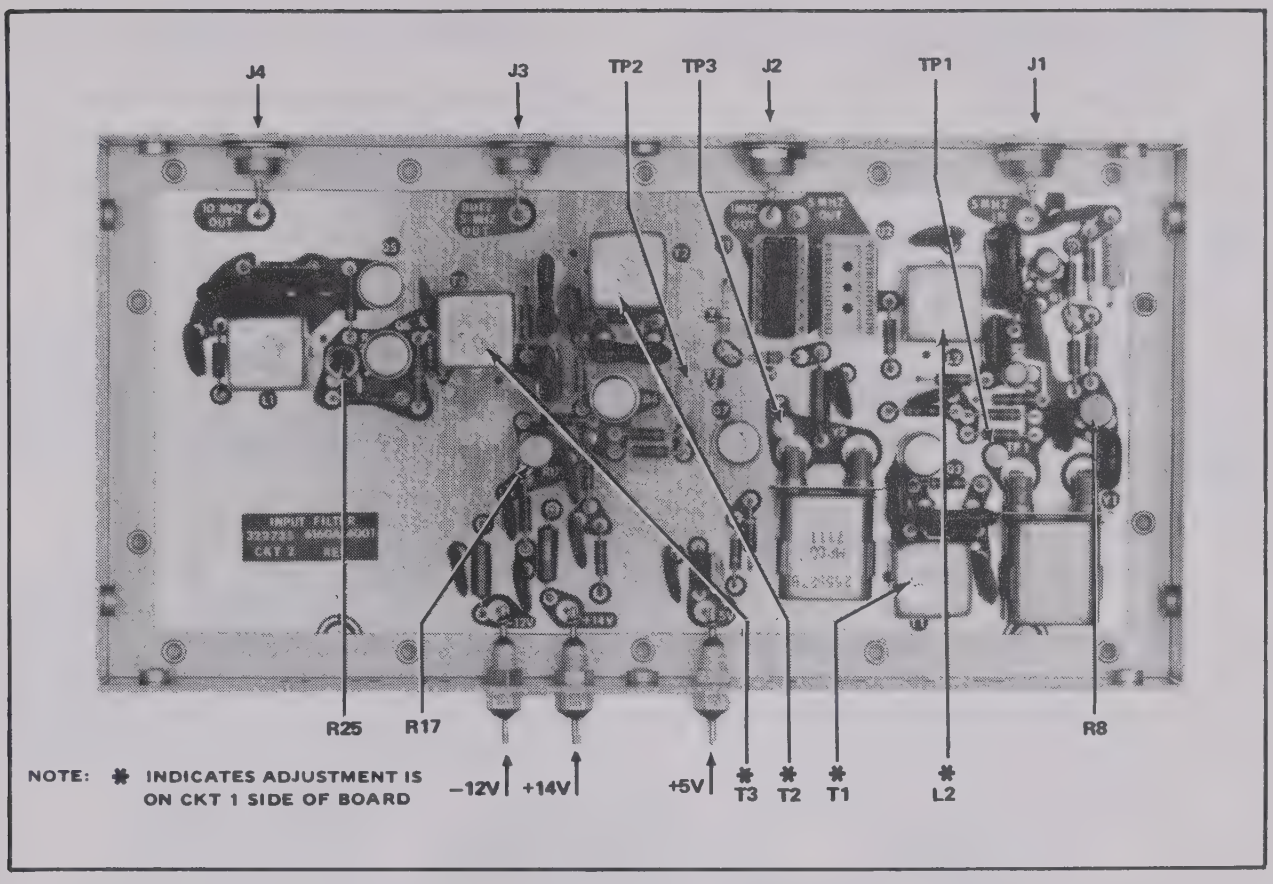



Figure 4-6. ADJUSTMENT, TEST POINT, AND INPUT/OUTPUT CONNECTOR LOCATIONS (6160A-4101)

4-44. Figure 4-6 shows adjustment, test point, and input/output connector locations on the Input Filter module. Alignment is as follows:

a. Remove the cover from the module.

b. Apply dc voltages (+5V, +14V, −12V) to appropriate feed-thru connectors on the module. Connect power supply common to the module chassis.

c. Apply a 5 MHz signal having a level of +7 dBm to J1.

d. Connect the input of an oscilloscope (probe) to TP1 and its ground lead to TP2.

e. Adjust L2 for maximum 5 MHz signal at TP1.

f. Connect the oscilloscope input to TP3 and then adjust T1 and T3 for maximum 5 MHz signal.

g. Connect the oscilloscope input together with a 50 ohm load to J4.

h. Adjust L1, T1, and T3 for maximum 10 MHz signal at J4.

i. Set the oscilloscope vertical sensitivity to 0.1 V/cm and adjust vertical centering until the upper peaks of the 10 MHz signal are at the center of the CRT.

j. Adjust R25 until each cycle of the 10 MHz signal at J4 are equal in amplitude (minimum 5 MHz component).

k. Adjust R8 for a 10 MHz peak-to-peak output of 1.1 $\pm$0.1V at J4.

l. Connect the input of an rf voltmeter together with a 50 ohm load to J3.

m. Adjust T2 for maximum rms voltage at J3.

n. Adjust R17 for a 1V rms output at J3.

o. Connect the oscilloscope input to J2, observing that the 5 MHz TTL output has a peak-to-peak amplitude of 3.5V.

p. Disconnect test equipment and replace module cover.

## 4-45. 1 MHz Digit Generator Module Set (6160B-4153)

4-46. The module set is aligned in two stages. First, the Step Loop (STP LP) module is aligned independently. Then the Main Loop Phase Detector (PH DET) and Main Loop (VCO) are aligned together with the Step Loop module. Prepare the module set for alignment as follows:

a. Disconnect cables and wiring from module set and remove set from synthesizer.

b. Remove module set joiners (2) and separate modules.

4-47. 1 MHZ STEP LOOP (6160B-4153-1)

4-48. Use the following test equipment for alignment of the Step Loop module.

a. Power Supply (+14 V dc, +5 V dc and −12V dc)

b. DVM

c. Frequency Counter

d. Spectrum Analyzer

4-49. Align the Step Loop (STP LP) module as follows:

a. Remove module side covers.

b. Connect dc supply voltage, 5 MHz TTL, and frequency counter (set for external standard mode) as shown in Figure 4-7.

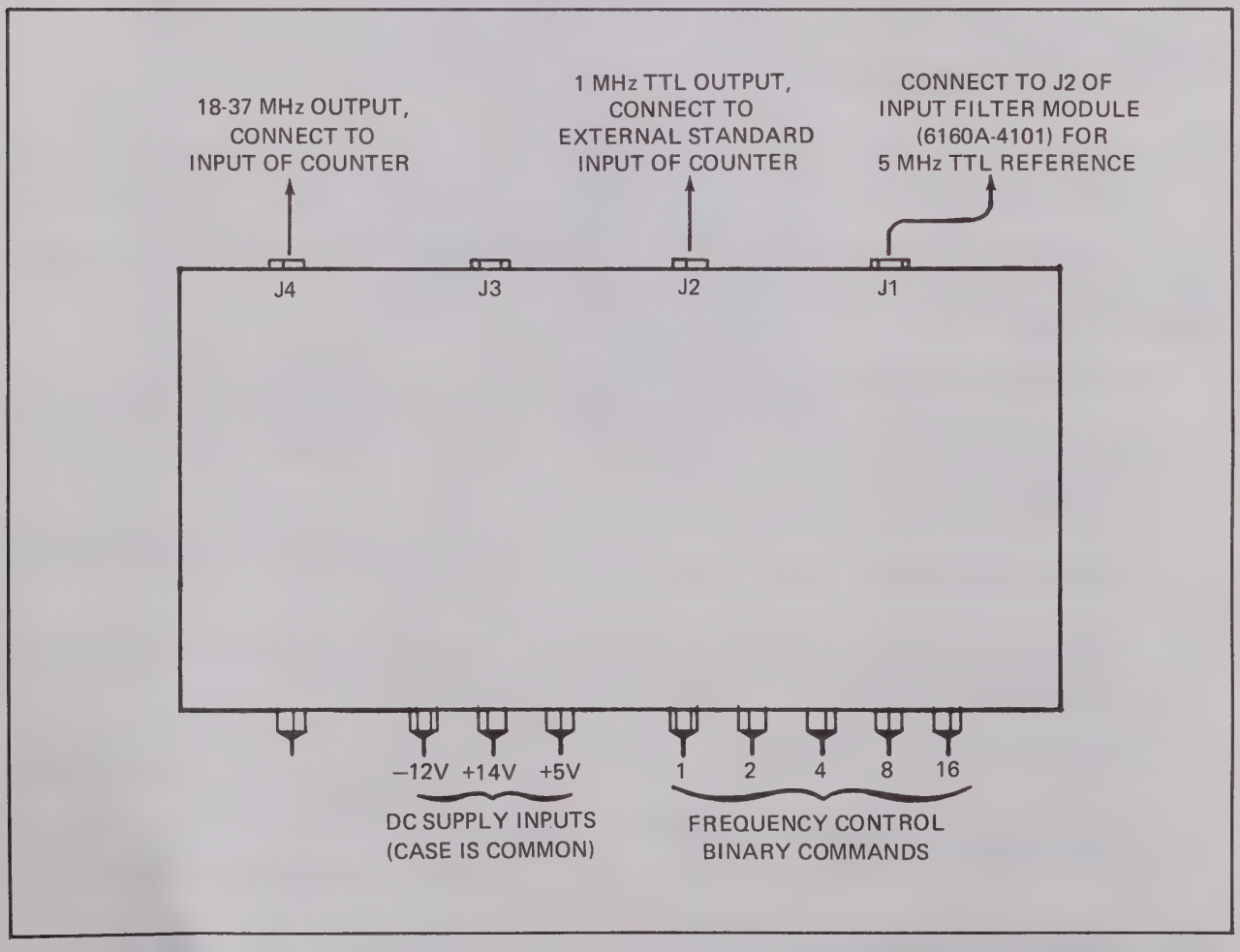

18-37 MHz OUTPUT, CONNECT TO INPUT OF COUNTER
1 MHz TTL OUTPUT, CONNECT TO EXTERNAL STANDARD INPUT OF COUNTER
CONNECT TO J2 OF INPUT FILTER MODULE (6160A-4101) FOR 5 MHz TTL REFERENCE
J4
J3
J2
J1
−12V +14V +5V
DC SUPPLY INPUTS (CASE IS COMMON)
1 2 4 8 16
FREQUENCY CONTROL BINARY COMMANDS

Figure 4-7. 1 MHz STEP LOOP EQUIPMENT CONNECTIONS.

Table 4-3. FREQUENCY CONTROL COMMANDS
1 MHz STEP LOOP

| J4 OUTPUT | GROUNDED TERMINALS |
|---|---|
| 18 | 16, 8, 4, 2, 1 |
| 19 | 16, 8, 4, 2 |
| 20 | 16, 8, 4, 1 |
| 21 | 16, 8, 4 |
| 22 | 16, 8, 2, 1 |
| 23 | 16, 8, 2 |
| 24 | 16, 8, 1 |
| 25 | 16, 8 |
| 26 | 16, 4, 2, 1 |
| 27 | 16, 4, 2 |
| 28 | 16, 4, 1 |
| 29 | 16, 4 |
| 30 | 16, 2, 1 |
| 31 | 16, 2 |
| 32 | 16, 1 |
| 33 | 16 |
| 34 | 8, 4, 2, 1 |
| 35 | 8, 4, 2 |
| 36 | 8, 4, 1 |
| 37 | 8, 4 |

c. Program STP LP module for 18 MHz output at J4 by grounding appropriate feedthrough terminals (Figure 4-7) in accordance with Table 4-3.

d. Connect DVM set for dc measurement to points indicated in Figure 4-8. Adjust L2 (See Figure 4-8 for location) for DVM indication within +1.49 Vdc to +1.51 Vdc.

e. Disconnect DVM.

f. Frequency counter should indicate 18 MHz.

g. Program STP LP module for frequencies from 19 to 37 MHz in 1 MHz steps and observe corresponding frequencies of 19 to 37 MHz on frequency counter.

h. Disconnect frequency counter and connect spectrum analyzer to J4 (18-37 MHz output).

i. Program STP LP for 20 MHz output at J4 and center output signal on spectrum analyzer display.

j. Program STP LP for 18 MHz and adjust C22 (See Figure 4-8 for location) for minimum upper 2 MHz sideband at center of display. (Spurious should be $\leqslant -90$ db from fundamental).

k. Program STP LP for 19 MHz output at J4.

l. Adjust C19 (See Figure 4-8) for minimum upper 1 MHz sideband at center of display on spectrum analyzer. (Spurious should be $\leqslant -70$ dB from fundamental).

m. Disconnect all test equipment and power connections from module. Install module side cover.

4-50. 1 MHZ MAIN LOOP VCO (6160B-4153-2) AND MAIN LOOP PHASE DETECTOR (6160B-4153-3).

4-51. These modules are aligned using the following test equipment.

a. Power Supply

b. Signal Generator

c. Frequency Counter

d. Oscilloscope

e. Previously aligned Step Loop module

4-52. Use the following procedure for aligning the Main Loop VCO and Phase Detector modules:

a. Remove side covers from Main Loop VCO module (6160B-4153-2) and Main Loop Phase Detector (PH DET) Module, 6160B-4153-3.

b. Interconnect modules as shown in Figure 4-9. Power supply inter-connection leads between VCO and PH DET modules should be long enough to allow access to adjustments within these two modules.

c. Connect test equipment to terminals shown in Figure 4-9.

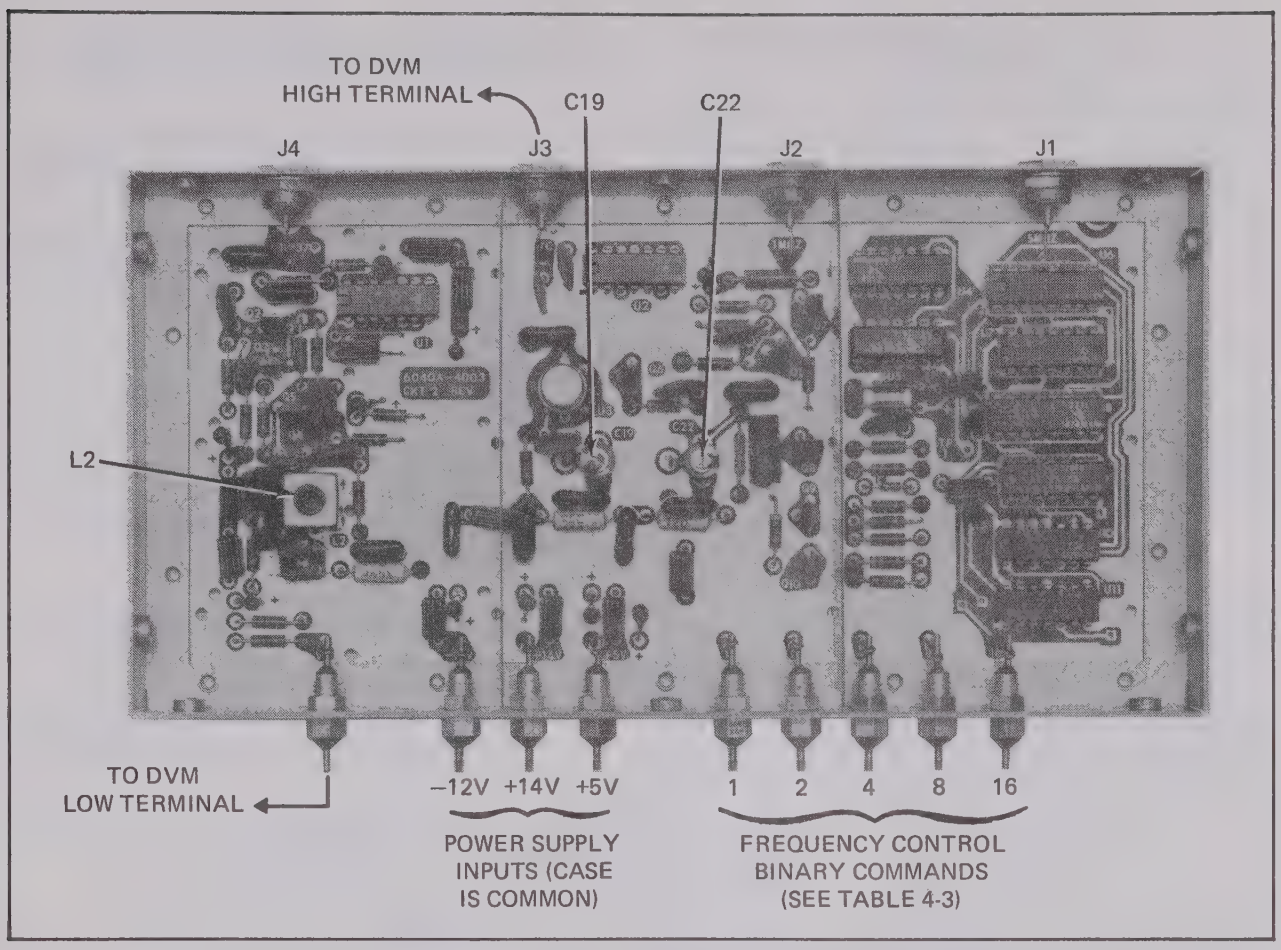



Figure 4-8. 1 MHz STEP LOOP (6160B-4153-1) ADJUSTMENT LOCATION AND DVM CONNECTION

d. Apply power to modules.

e. Adjust signal generator, connected to J3 of PH DET, for 20 MHz output.

f. Program STP LP module for 37 MHz, refer to Table 4-3.

g. Adjust VCO inductor L8 for frequency counter display between 20.15 MHz and 20.25 MHz.

h. Program STP LP for 18 MHz, refer to Table 4-3.

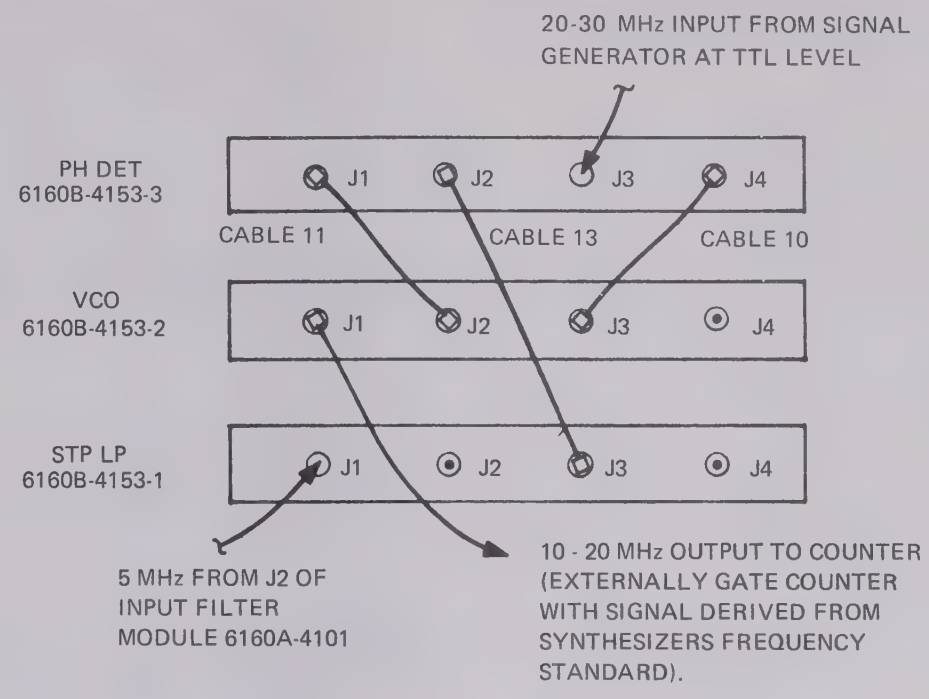
i. Adjust PH DET potentiometer R5 for frequency counter indication between 10.65 MHz and 10.75 MHz.

j. Re-check steps f through i and, if necessary, reset adjustment.

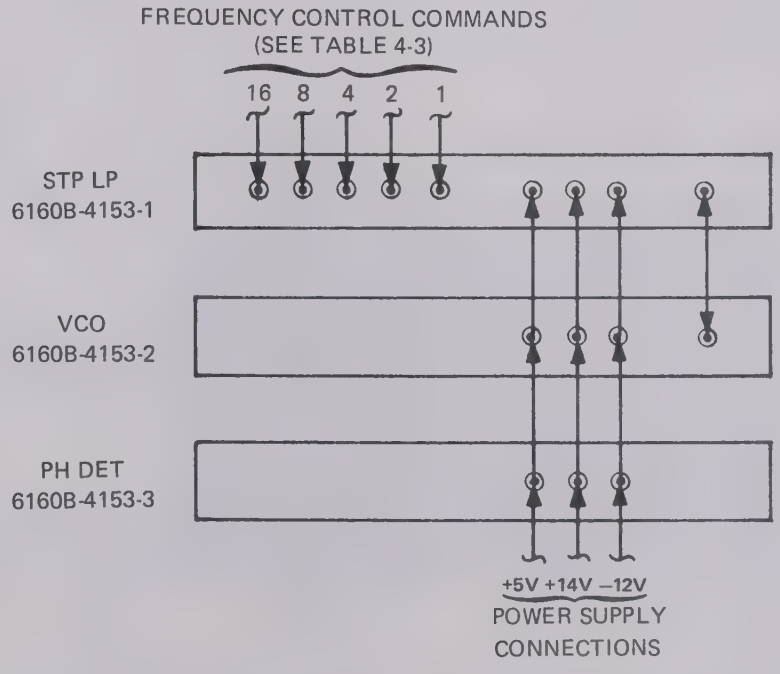
k. Program STP LP from 19 to 36 MHz and observe that frequency counter indication is in accordance with Table 4-4.

Table 4-4. J1 VCO OUTPUT

| PROGRAMMED FREQUENCY (MHz) | MAIN LOOP VCO OUTPUT J4 (MHz) | |
|---|---|---|
| | MIN | MAX |
| 19 | 11.15 | 11.5 |
| 20 | 11.65 | 12.0 |
| 21 | 12.15 | 12.5 |
| 22 | 12.65 | 13.0 |
| 23 | 13.15 | 13.5 |
| 24 | 13.65 | 14.0 |
| 25 | 14.15 | 14.5 |
| 26 | 14.65 | 15.0 |
| 27 | 15.15 | 15.5 |
| 28 | 15.65 | 16.0 |
| 29 | 16.15 | 16.5 |
| 30 | 16.65 | 17.0 |
| 31 | 17.15 | 17.5 |
| 32 | 17.65 | 18.0 |
| 33 | 18.15 | 18.5 |
| 34 | 18.65 | 19.0 |
| 35 | 19.15 | 19.5 |
| 36 | 19.65 | 20.0 |




MODULE TOP VIEW




MODULE BOTTOM VIEW

Figure 4-9. 1 MHz DIGIT GENERATOR EQUIPMENT CONNECTIONS, No. 1

l. Disconnect signal generator from J3 on PH DET and connect J4 of STP LP to J4 of VCO as shown in Figure 4-10

q. Program STP LP, from 18 to 37 MHz and observe that amplitude of signal displayed on oscilloscope is greater than 80 mV p-p for all programmed frequencies from 18 to 37 MHz.

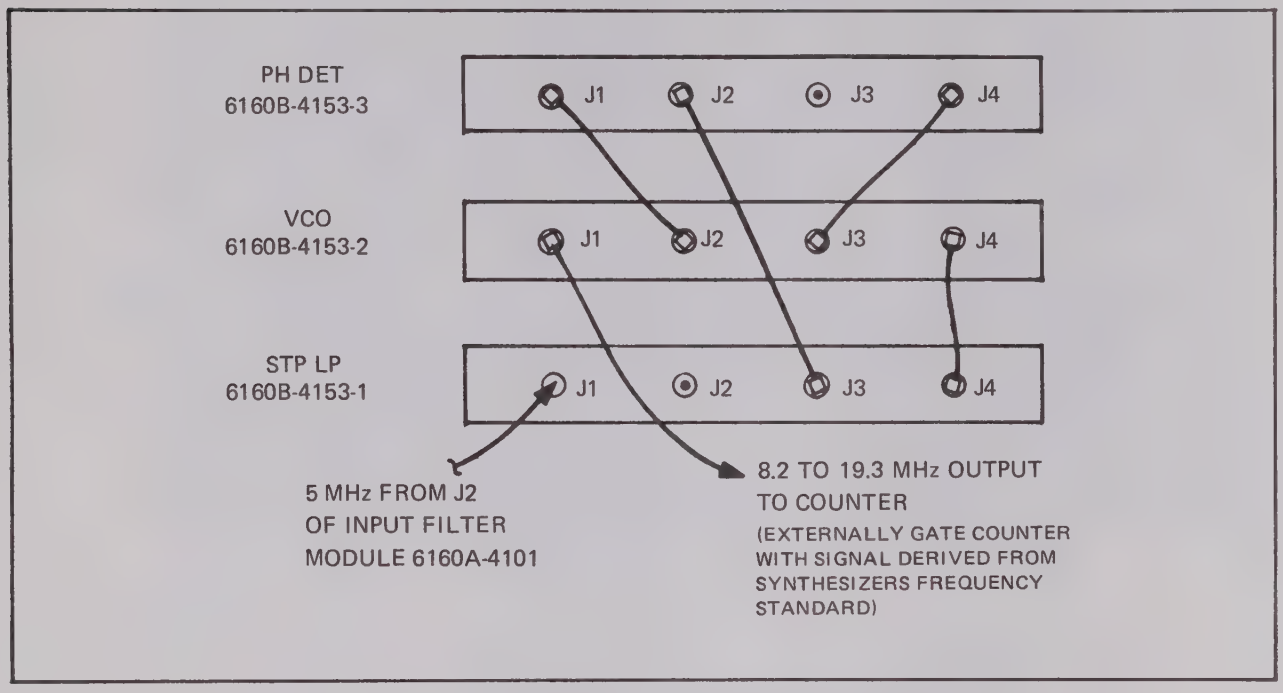



Figure 4-10. 1 MHz DIGIT GENERATOR EQUIPMENT CONNECTIONS, No. 2.

m. Program STP LP from 18 to 37 MHz and observe on frequency counter that VCO output at J1 is in accordance with Table 4-5.

*NOTE!*

*If VCO output does not meet limits specified in Table 4-5, VCO and PH DET modules must be retuned. If retuning is necessary, remove connection between STP LP module, J4, and VCO module, J4. Reconnect signal generator to J3 of PH DET module and repeat procedure beginning sith Step e.*

n. Connect signal generator set to 20 MHz to J3 of PH DET module.

o. Program STP LP module from 18 to 37 MHz and observe that frequency displayed on counter agrees with Table 4-6.

p. Remove frequency counter and connect oscilloscope to J4 from inside of VCO module.

Table 4-5. J1 VCO OUTPUT (J4 VCO TO J4 STP LP)

| PROGRAMMED STEP LOOP FREQUENCY (MHz) | MAIN LOOP VCO OUTPUT J1 (MHz) | |
|---|---|---|
| | MIN | MAX |
| 18 | 8.2 | 9.8 |
| 19 | 8.7 | 10.3 |
| 20 | 9.2 | 10.8 |
| 21 | 9.7 | 11.3 |
| 22 | 10.2 | 11.8 |
| 23 | 10.7 | 12.3 |
| 24 | 11.2 | 12.8 |
| 25 | 11.7 | 13.3 |
| 26 | 12.2 | 13.8 |
| 27 | 12.7 | 14.3 |
| 28 | 13.2 | 14.8 |
| 29 | 13.7 | 15.3 |
| 30 | 14.2 | 15.8 |
| 31 | 14.7 | 16.3 |
| 32 | 15.2 | 16.8 |
| 33 | 15.7 | 17.3 |
| 34 | 16.2 | 17.8 |
| 35 | 16.7 | 18.3 |
| 36 | 17.2 | 18.8 |
| 37 | 17.7 | 19.3 |

Table 4-6. VCO OUTPUT CHECK

| PROGRAMMED FREQUENCY MHz | VCO OUTPUT J1 |
|---|---|
| 18 | 10.0 |
| 19 | 10.5 |
| 20 | 11.0 |
| 21 | 11.5 |
| 22 | 12.0 |
| 23 | 12.5 |
| 24 | 13.0 |
| 25 | 13.5 |
| 26 | 14.0 |
| 27 | 14.5 |
| 28 | 15.0 |
| 29 | 15.5 |
| 30 | 16.0 |
| 31 | 16.5 |
| 32 | 17.0 |
| 33 | 17.5 |
| 34 | 18.0 |
| 35 | 18.5 |
| 36 | 19.0 |
| 37 | 19.5 |

NOTE: Stability of J1 output depends upon stability of signal generator used.

r. Remove all test equipment and module interconnections.

s. Attach module side covers.

t. Refer to Figure 4-11 and assemble module set in order shown. Attach module set joiners (2).

u. Secure module set to synthesizer. Connect numbered cables in accordance with Figure 4-11 Connect wiring in accordance with Figure 4-3.

## 4-53. Six Digit Generator (6040A-4102)

4-54. This module is aligned within the synthesizer (See Figure 4-1 for location). Tilt the hinged assembly up after removing the four screws securing the module to the synthesizer. Remove the module cover to expose the pcb and adjustments. Adjustment and test point locations are illustrated in Figure 4-12. Use the following test equipment to align this module.

a. DVM.

b. Oscilloscope.

c. Frequency Counter.

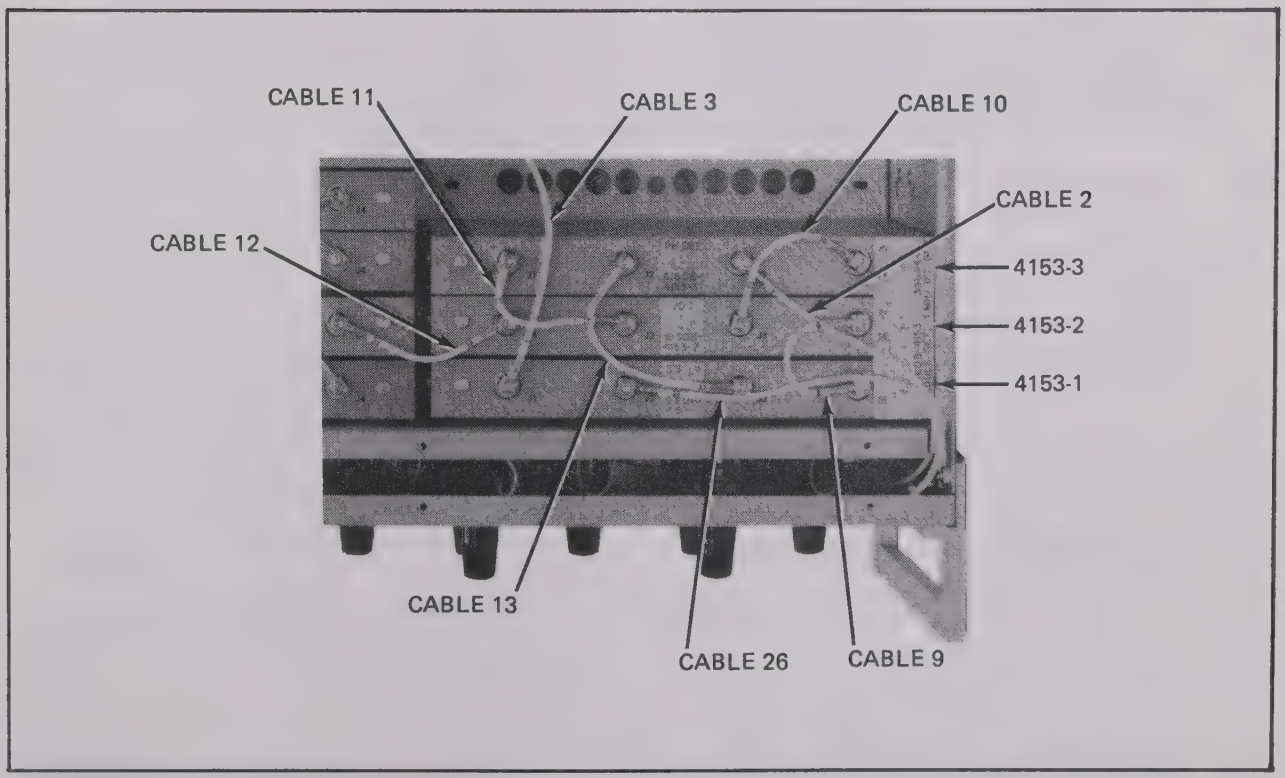



Figure 4-11. 1 MHz MODULE SET CABLING CONNECTIONS

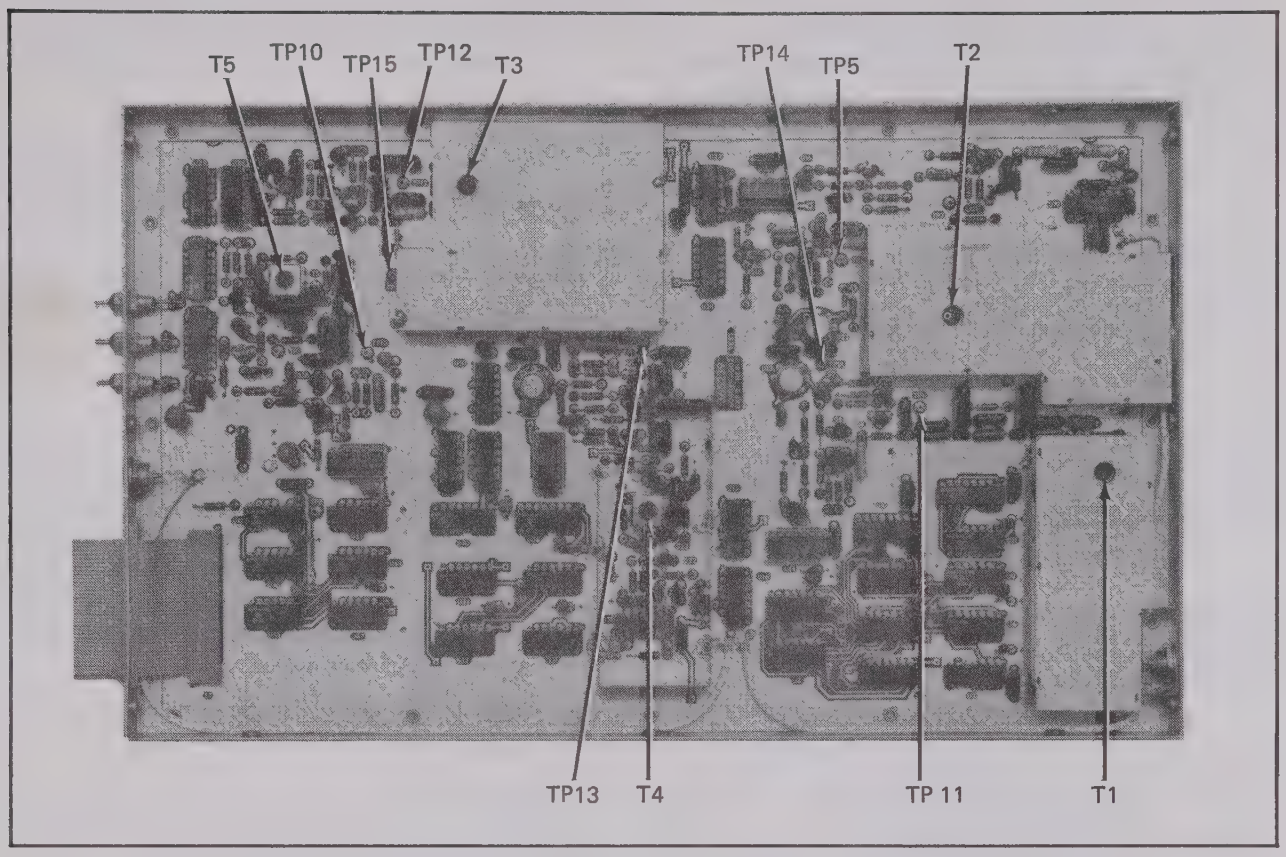



Figure 4-12. SIX DIGIT GENERATOR ADJUSTMENTS AND TEST POINTS

d. DVM Input Filter (1000 pf ±5% capacitor, across DVM input terminals and 10 kΩ ±1% resistor in series with HI input lead to DVM).

4-55. 10 HZ STEP LOOP

a. Connect DVM set for dc measurement, through input filter to TP 10 (+) and ground (module frame). Set FUNCTION switch to 10-160 MHz and dial 80.000000 MHz.

b. Adjust T5 for +3.5 Vdc ±0.1 Vdc indication on DVM.

c. Dial 80.000049 MHz and observe that DVM indication is greater than +1.9V.

4-56. 1 KHZ STEP LOOP

a. Connect DVM through filter to TP13 (+) and ground. Dial 80.004950 MHz.

b. Adjust T4 for +2.5 Vdc ±0.1 Vdc indication on DVM.

c. Dial 80.000000 MHz and observe DVM indication between +5.0 and +6.2 Vdc.

4-57. 100 KHZ STEP LOOP

a. Connect DVM through filter to TP11 (+) and ground. Dial 80.000000 MHz.

b. Adjust T1 for 2.5 Vdc ±0.1 Vdc indication on DVM.

c. Dial 80.495000 MHz and observe DVM indication between +7.4 to +8.6 Vdc.

4-58. 1 KHZ MAIN LOOP

a. Connect DVM low input, through filter, to TP15 and high input to TP12. Dial 80.000049 MHz.

b. Adjust T3 for 0 Vdc within the limits of 0 Vdc to +0.05 Vdc.

c. Vary the 1, 10, 100, 1000 Hz frequency dials throughout their ranges noting the maximum and minimum DVM indications. The minimum indication should be between 0V and +0.5 Vdc and the maximum indication should be less than +0.38 Vdc.

d. If minimum indication occurs at dial setting other than 80.000049 MHz, repeat step b at frequency of minimum voltage.

e. Repeat step c.

*NOTE!*

*A maximum indication greater than +0.38 indicates the varactor diodes, CR10 and CR7, are not tracking properly and should be replaced.*

4-59. 100 KHZ MAIN LOOP

a. Connect low input of DVM, through filter, to TP14 and high input to TP5. Dial 80.999999 MHz.

b. Adjust T2 for –0.17 Vdc within the limits of –0.15 Vdc to –0.20 Vdc.

c. Set the 1 and 10 Hz dials to 49 and vary the 100 Hz, 1 kHz, 10 kHz, and 100 kHz dials throughout their ranges. Note the maximum and minimum indications on the DVM. The maximum indication should be more negative than –0.15 Vdc and the minimum indication more positive than –0.50 Vdc.

d. If maximum indication is more positive than –0.15V, repeat step b at frequency of maximum voltage.

e. Repeat step c.

*NOTE*

*Any adjustment of T1, T2, T3 or T4, or related circuitry, will necessitate the repeating of procedures 4-58 and 4-59.*

*NOTE!*

*A minimum voltage more negative than –0.50 Vdc indicates that varactor diodes CR1 and CR2 are not tracking properly and should be replaced.*

4-60. SYNTHESIS CHECK

a. Connect frequency counter to J2 of module and perform first ten steps of Table 4-16.

b. Remove DVM and frequency counter.

c. Install cover on module. Tilt module assembly down into synthesizer and secure with four screws.

## 4-61. 10 MHz Main Loop Phase Detector (6160A-4109)

4-62. This module is removed from the synthesizer and aligned with the following equipment.

a. Power Supply.

b. Signal Generator (2).

c. Oscilloscope.

d. 6 db Splitter.

e. 10 db Attenuator.

f. Digital Voltmeter.

g. 50 ohm load.

4-63. Figure 4-13 shows adjustment test point, and input output connector locations on the 10 MHz D.U. Main P.D. module. Alignment is as follows:

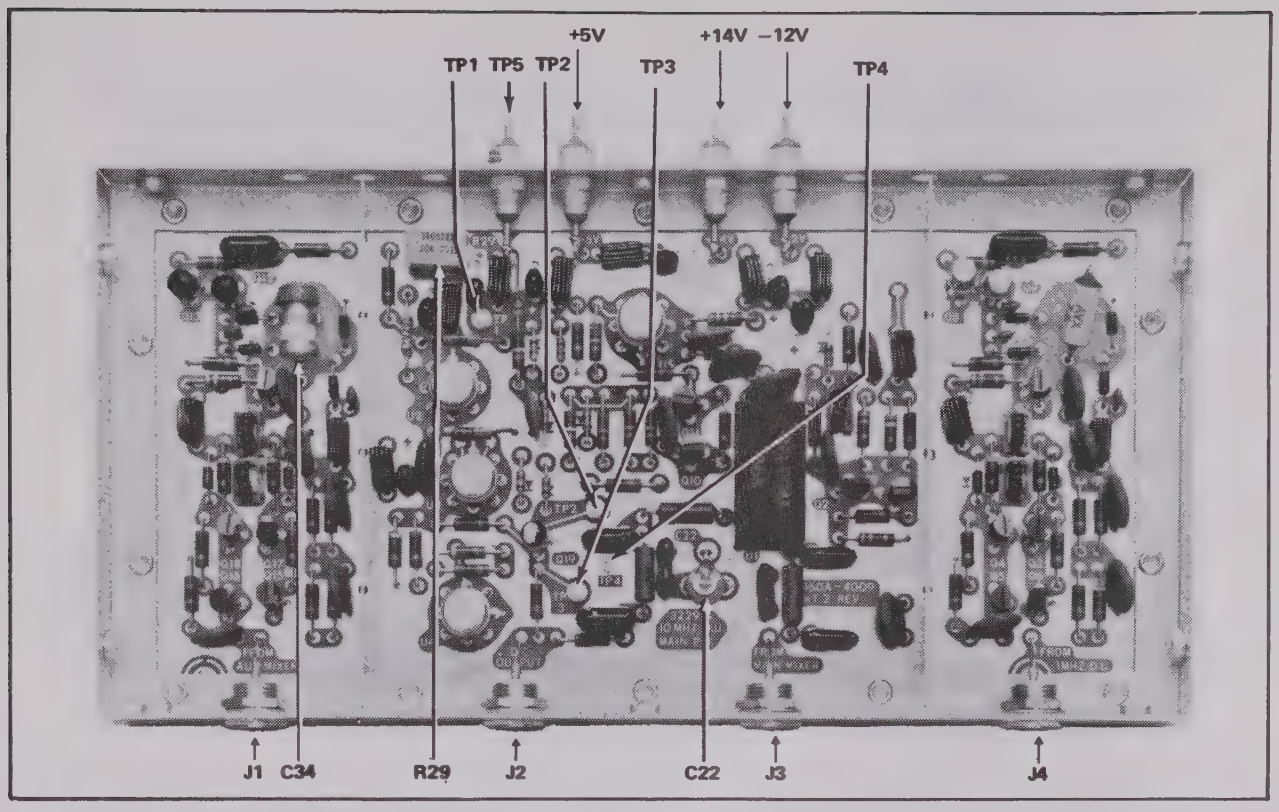



Figure 4-13. ADJUSTMENT, TEST POINT, INPUT/OUTPUT CONNECTOR LOCATIONS (6160A-4109)

a. Remove the cover from module.

b. Apply dc voltages (+5V, +14V, −12V) to the appropriate feed-thru connectors on the module. Connect power supply common to the module chassis.

c. Connect the input of an oscilloscope to J2. Set the oscilloscope to dc input and establish a 0V reference.

d. Connect a 50 ohm load to J3 and connect a shorting jumper between −12V input and TP5 feed-thru connector.

e. Adjust R29 for 0V dc at J2.

f. Make the test equipment connections shown in Figure 4-14.

g. Set signal generator No. 1 to 15 MHz and connect A output to J1 and B output to J4.

h. Adjust C34 for 0 Vdc at J2.

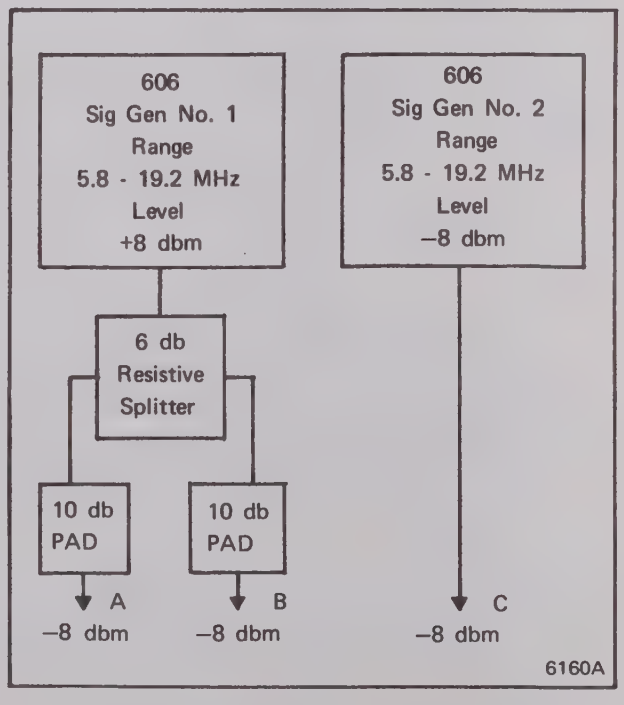



Figure 4-14. EQUIPMENT CONNECTION FOR 10 MHz D. U. MAIN PD TEST

i. Tune signal generator No. 1 from 10 to 19 MHz, observing that the dc voltage at J2 does not change more than +4 mV. If necessary, adjust C34 to satisfy this requirement.

j. Set signal generator No. 1 to 15 MHz and adjust R29 for 0 Vdc at J2.

k. Disconnect 50 ohm load from J3 and connect the output (C) of signal generator No. 2 to J3.

l. Set signal generator No. 1 to 10 MHz and signal generator No. 2 to 20 MHz. Also disconnect

m. Connect a shorting jumper between TP2 and TP4 and adjust C22 for a minimum amplitude (less than 40 mV peak-to-peak) 10 MHz signal at J2.

n. Set signal generator No. 1 to 15 MHz and No. 2 to 16 MHz, observing that the 1 MHz signal at J2 has a peak-to-peak amplitude of 40 mV. Offset should be less than +2 mVdc.

o. Disconnect shorting jumper between TP2 and TP4.

p. Connect digital voltmeter to TP2 (+) and TP4 (–).

q. Tune signal generator No. 2 from 12 MHz to 18 MHz, observing that the voltage at TP2 is –10.7 ±0.7 Vdc, except when signal generator frequency is 15 ±0.02 MHz. At 15 ±0.02 MHz the voltage at TP2 should be 0 ±50 mV.

r. Disconnect signal generator No. 1 output (B) from J4 and signal generator No. 2 output (C) from J3.

s. Connect signal generator No. 2 output (C) to J4 and tune it slowly down from 15 MHz. The voltage at J2 should decrease from 0 ±2 mV to –22 +5 mV at a signal generator No. 2 frequency of 14.2. to 13.8 MHz.

t. Slowly increase signal generator No. 2 frequency, observing that the voltage at J2 increases from 0 +2 mV to +22 ±5 mV at a signal generator frequency of 15.8 to 16.2 MHz.

u. Connect a shorting jumper between –12V and TP5 feed-thru connector.

v. Connect digital voltmeter to TP3 (+) and TP4 (–).

w. Tune signal generator No. 2 until the voltage at TP3 is 1 ±0.05 Vdc.

x. Connect a shorting jumper between TP2 and TP4. observing that the voltage at TP3 is 0 ±35 mV.

z. Disconnect test equipment and replace module cover.

## 4-64. 10 MHz Step Loop Phase Detector (6160A-4106-1)

4-65. This module is removed from the synthesizer and aligned with the following equipment:

a. Power Supply.

b. Oscilloscope

c. Signal Generator (2).

d. Digital Voltmeter.

e. 50 ohm Load

f. 6.8k, ¼W Resistor

g. 12k, ¼W Resistor.

4-66. Figure 4-15 shows adjustment, test point, and input/output connector locations on the 10 MHz D. U. Step Loop P. D. module. Alignment is as follows:

a. Remove the cover from the module.

b. Connect the input of an oscilloscope (probe) to TP4 and its ground lead to TP3.

c. Apply a 10 MHz signal having a level of +13 dbm +2 db to J2.

d. Adjust C13 for minimum amplitude 10 MHz signal (less than 70 mV peak-to-peak at TP4).

e. Disconnect the oscilloscope and signal generator from the module.

f. Apply dc voltages (+5V, +14V, –12V) to appropriate feed-thru connectors on the module. Connect power supply common to the module chassis.

g. Apply +5V to "4" feed-thru connector.

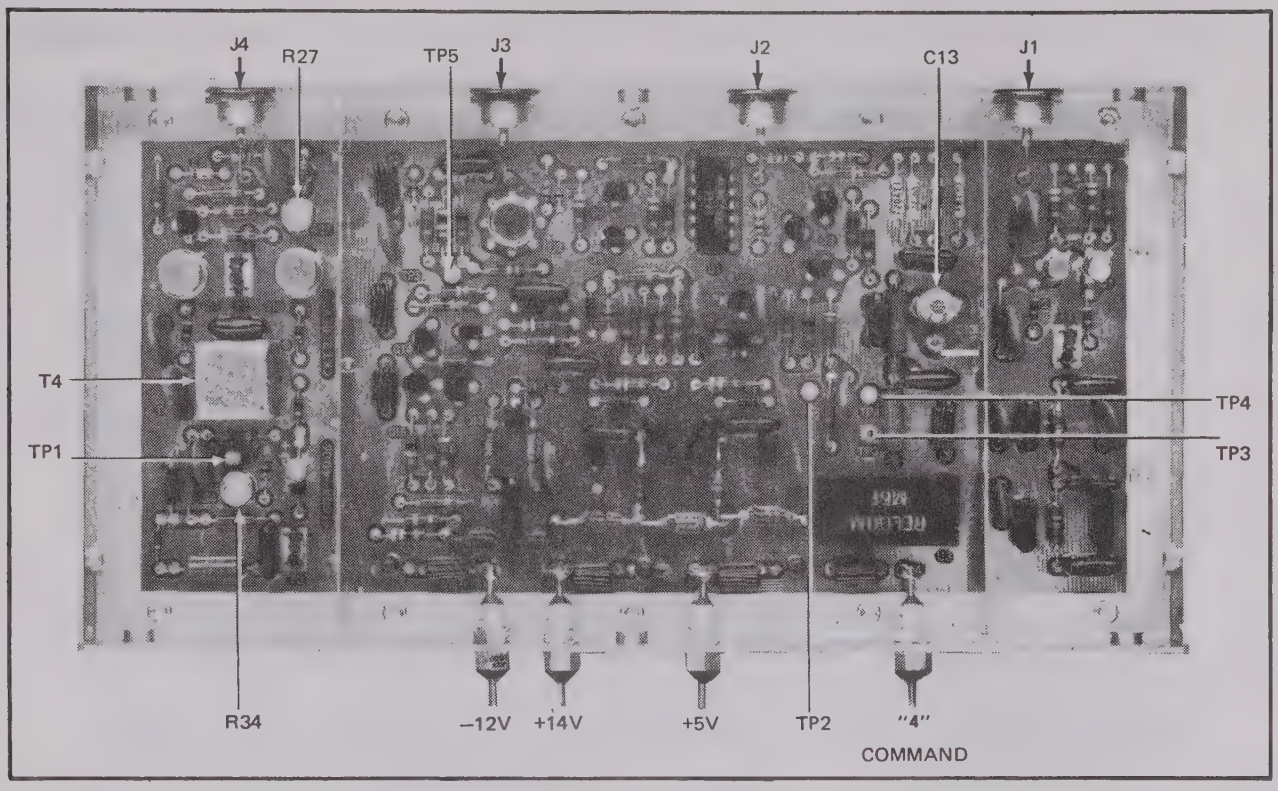



Figure 4-15. ADJUSTMENT, TEST POINT, INPUT/OUTPUT CONNECTOR LOCATIONS (6160A-4106-1)

h. Apply a 140 MHz signal having a level of +5 dbm +2 db to J1.

i. Connect a digital voltmeter together with a 50 ohm load to J2, observing that the dc voltage is 0 ±0.6 mV. Disconnect the digital voltmeter upon completion of this step.

j. Apply a 10 MHz signal having an amplitude of +7 dbm ±2 db to J4.

k. Connect the input of an oscilloscope (probe) to TP1 and its ground lead to TP3.

l. Adjust T4 for maximum amplitude 10 MHz signal at TP1.

m. Adjust R27 for a 10 MHz signal having a peak-to-peak amplitude of 3V at TP1.

n. Adjust R34 until the notch in the 10 MHz waveform is slightly above the center point (zero crossing).

o. Repeat step 1, and n. until results are obtained without further adjustment.

p. Connect the input of the oscilloscope together with a 50 ohm load to J2.

q. Connect a shorting jumper between TP2 and TP3. Also disconnect +5V from "4" feed-thru and then ground the feed-thru.

r. Apply a 71 MHz signal having a level of +5 dbm ±2 db to J1.

s. Adjust R27 for a 1 MHz beat signal at J2 which has a peak-to-peak amplitude of 60 +0/–5 mV.

t. Perform the checks in Table 4-7, observing that the 1 MHz beat signal at J2 has a peak-to-peak amplitude of 35 to 60 mV.

Table 4-7. BEAT SIGNAL CHECKS

| J1 FREQ (MHz) | "4" FEED-THRU |
|---|---|
| 71 | GND |
| 81 | GND |
| 91 | GND |
| 101 | GND |
| 111 | +5V |
| 121 | +5V |
| 131 | +5V |
| 141 | +5V |

u. Disconnect the shorting jumper from TP2.

v. Apply a 141 MHz signal having a level of +5 dbm ±2 db to J1. Also ensure that the "4" feed-thru connector has +5V applied.

w. Connect a digital voltmeter to TP5 (+) and TP3 (–), observing that the voltage at TP5 is +2 to +3 Vdc.

x. Establish a 0V reference (dc coupled input)on the oscilloscope connected to J2.

y. Apply –12 Vdc via a 6.8k, ¼W resistor to J3, observing that the peaks of the output signal at J2 shift –10 ±2 mVdc.

z. Apply +14 Vdc via a 12k, ¼W resistor to J3, observing that the peaks of the input signal at J2 shift +10 ±2 mVdc.

aa. Disconnect test equipment and replace module cover.

## 4-67. 10 MHz Step Loop VCO (6160A-4107-1)

4-68. This module is removed from the synthesizer and aligned with the following equipment:

a. Power Supply (2).

b. Frequency Counter.

c. Digital Voltmeter.

d. RF Voltmeter.

e. Signal Generator.

f. 50 ohm load.

g. 1k ohm load.

h. 33k, ¼W Resistor.

i. 39k, ¼W Resistor.

j. 3M, ¼W Resistor

k. 3.3M, ¼W Resistor.

l. 130Ω, ¼W Resistor.

4-69. Figure 4-16 shows adjustment, test point, and input/output connector locations on the 10 MHz Step Loop VCO module. Alignment is as follows:

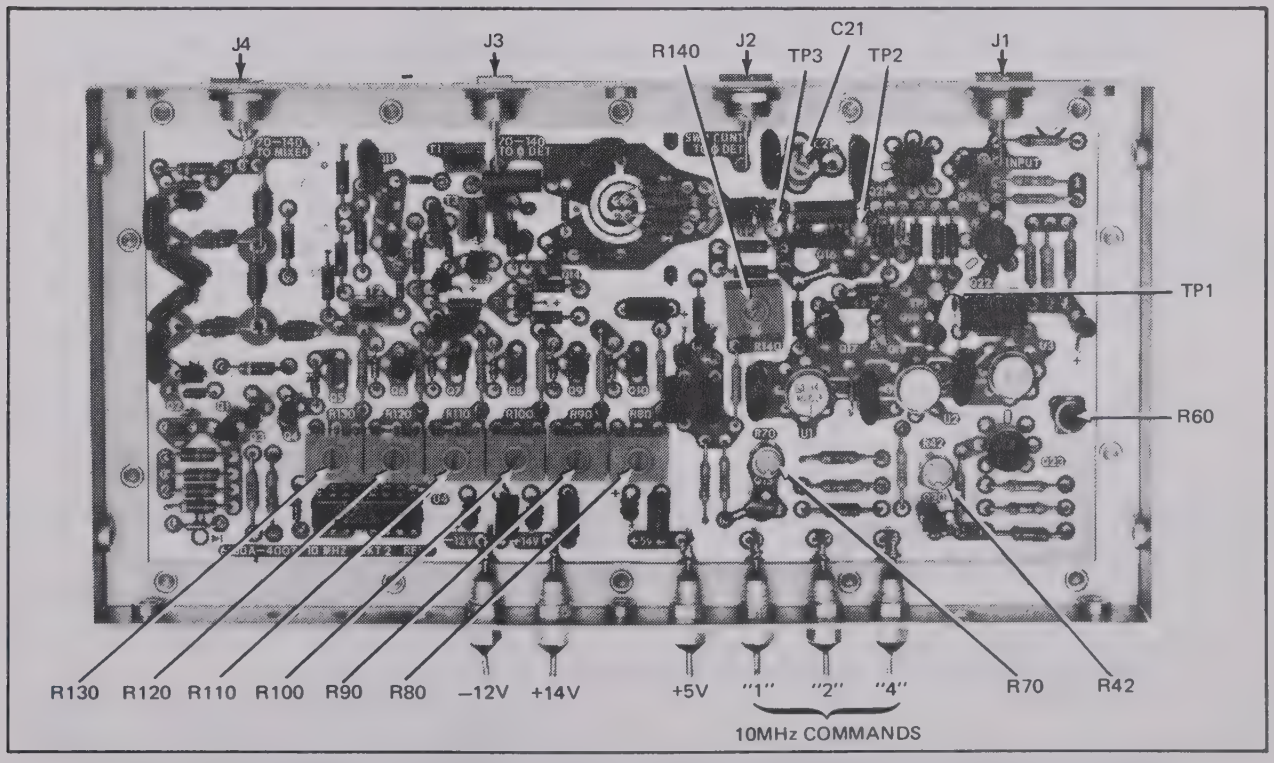



Figure 4-16. ADJUSTMENT, TEST POINT, INPUT/OUTPUT CONNECTOR LOCATIONS (6160A-4107-1)

a. Remove the cover from the module.

b. Apply dc voltages (+5V, +14V, −12V) to appropriate feed-thru connectors on the module. Connect power supply common to the module chassis.

c. Apply −12 Vdc via a 33k, ¼W resistor to J1. Also connect a 130Ω, ¼W resistor from J1 to ground.

d. Connect a digital voltmeter to TP1 (+) and the module chassis (−).

e. Jumper the "4", "2", "1" feed-thru connectors to ground (one at a time) until the voltage at TP1 is nearly 8V, but less than 8V.

f. Disconnect the input voltage of J1 and then adjust R60 until a point is found where adjustment either direction causes the voltage at TP1 to increase or decrease a few hundred mV.

g. Apply −12 Vdc via a 3M, ¼W resistor to J1. observing that the voltage at TP1 decreases the same amount as in step f.

h. Apply +14V via a 3.3M, ¼W resistor to J1, observing that the voltage at TP1 increases the same amount as in step f.

i. Repeat steps f, thru h. until all results are obtained without further adjustment.

j. Connect the input of a frequency counter to J4.

k. Jumper only the "2", "1" feed-thru connectors to ground.

l. Apply −12 Vdc via a 33k, ¼W resistor to J1 and adjust R110 and R140 for a 7 MHz indication on the frequency counter.

m. Apply +14 Vdc via a 39k, ¼W resistor to J1.

n. Adjust R42 for a 3 MHz indication on the frequency counter.

o. Jumper the "4", "2", "1" feed-thru connectors to ground.

p. Apply 12 Vdc via a 33k, ¼W resistor to J1 and record the freqeuncy counter indication.

q. Apply +14 Vdc via a 39k, ¼W resistor to J1 and record the frequency counter indication.

r. Repeat steps p and q and adjust R70 until same frequency counter indication is observed in both steps.

s. Disconnect jumpers from "4", "2","1" feed-thru connectors.

t. Repeat steps p and q and adjust R140 until the same frequency counter indication is observed in both steps.

u. Jumper only "4", "2" feed-thru connectors to ground.

v. Repeat steps p and q and adjust R80 until the same frequency is observed in both steps.

w. Jumper only "4", "1" feed-thru connectors to ground.

x. Repeat steps p and q, and adjust R90 until the same frequency is observed in both steps.

y. Jumper only "4" feed-thru connector to ground.

z. Repeat steps p and q, and adjust R100 until the same frequency is observed in both steps.

aa. Jumper only "2", "1" feed-thru connectors to ground.

ab. Repeat steps p and q, and adjust R110 untll the same frequency is observed in both steps.

ac. Jumper only "2" feed-thru connector to ground.

ad. Repeat steps p and q and adjust R120 until the same frequency is observed in both steps.

ae. Jumper only "1" feed-thru connector to ground.

af. Repeat steps p and q and adjust R130 until the same frequency is observed in both steps.

ag. Jumper the "4", "2", "1" feed-thru connectors to ground and apply −12 Vdc via a 33k, ¼W resistor to J1.

ah. Observed that the voltage at TP1 is at least +1 Vdc. If not, lengthen two loops of wire (No. 1, No. 2) until thereis a +1 Vdc at TP1.

ai. Disconnect the jumpers from the "4", "2", "1" feed-thru connectors, observing that the voltage at TP1 is less than +11.4 Vdc.

aj. Apply +14 Vdc via a 39k, ¼W resistor to J1, observing that the voltage at TP1 is less than +12.2 Vdc.

ak. Disconnect +5V, +14V, −12V input power to the module and connect the input of an rf voltmeter to TP3.

al. Apply a 10 MHz signal having a level of 1V rms to TP3 and adjust C21 for maximum rms voltage at TP3.

am. Disconnect rf voltmeter and 10 MHz signal.

an. Apply dc voltages (+5V, +14V, −12V) to the appropriate feed-thru connectors. Connect power supply common to the module chassis.

ao. Connect an rf voltmeter together with a 50 ohm load to J3.

ap. Apply −12 Vdc via a 33k, ¼W resistor to J1 and perform output checks in Table 4-8.

Table 4-8. 70MHz THRU 100MHz OUTPUT CHECKS

| STEP | GROUNDED TERMINAL | J3 OUTPUT LEVEL |
|---|---|---|
| 1 | 4, 2, 1 | 3 ±2dbm |
| 2 | 4, 2 | |
| 3 | 4, 1 | |
| 4 | 4 | |

aq. Apply +14 Vdc via a 39k, ¼W resistor to J1 and perform the output checks in Table 4-9.

Table 4-9. 110MHz THRU 140MHz OUTPUT CHECKS

| STEP | GROUNDED TERMINAL | J3 OUTPUT LEVEL |
|---|---|---|
| 1 | 2, 1 | 3 ±2dbm |
| 2 | 2 | |
| 3 | 1 | |
| 4 | NONE | |

ar. Connect rf voltmeter together with 50 ohm load to J4.

as. Repeat steps ap, and aq., observing that a 1.5 ±1 dbm output is present at J4.

at. Connect the digital voltmeter together with a 1k ohm load to J2.

au. Apply −12 Vdc via a 33k, ¼W resistor to J1, observing that the output voltage at J2 is +1.1 ±0.1 Vdc.

av. Apply +14 Vdc via a 39k, ¼W resistor to J1, observing that the output voltage at J2 is −1.5 ±0.1 Vdc.

aw. Disconnect test equipment and replace module cover.

## 4-70. 10 MHz I.F. Mixer (6160A-4108)

4-71. This module is removed from the synthesizer and aligned with the following equipment:

a. Power Supply

b. Signal Generator (2).

c. RF Voltmeter (with rf probe).

d. 50 ohm load (2).

4-72. Figure 4-17 shows adjustment, test point, and input/output connector locations on the 10 MHz D.U.I.F. Mixer module. Alignment is as follows:

a. Remove the cover from the module.

b. Apply dc voltages (+5V, +14V, −12V) to the appropriate feed-thru connectors on the module. Connect power supply common to the module chassis.

c. Apply 1 115 MHz signal having a level of +5 dbm ±2 db to J1.

d. Apply a 100 MHz signal having a level of +1 dbm ±0.5 db to J2.

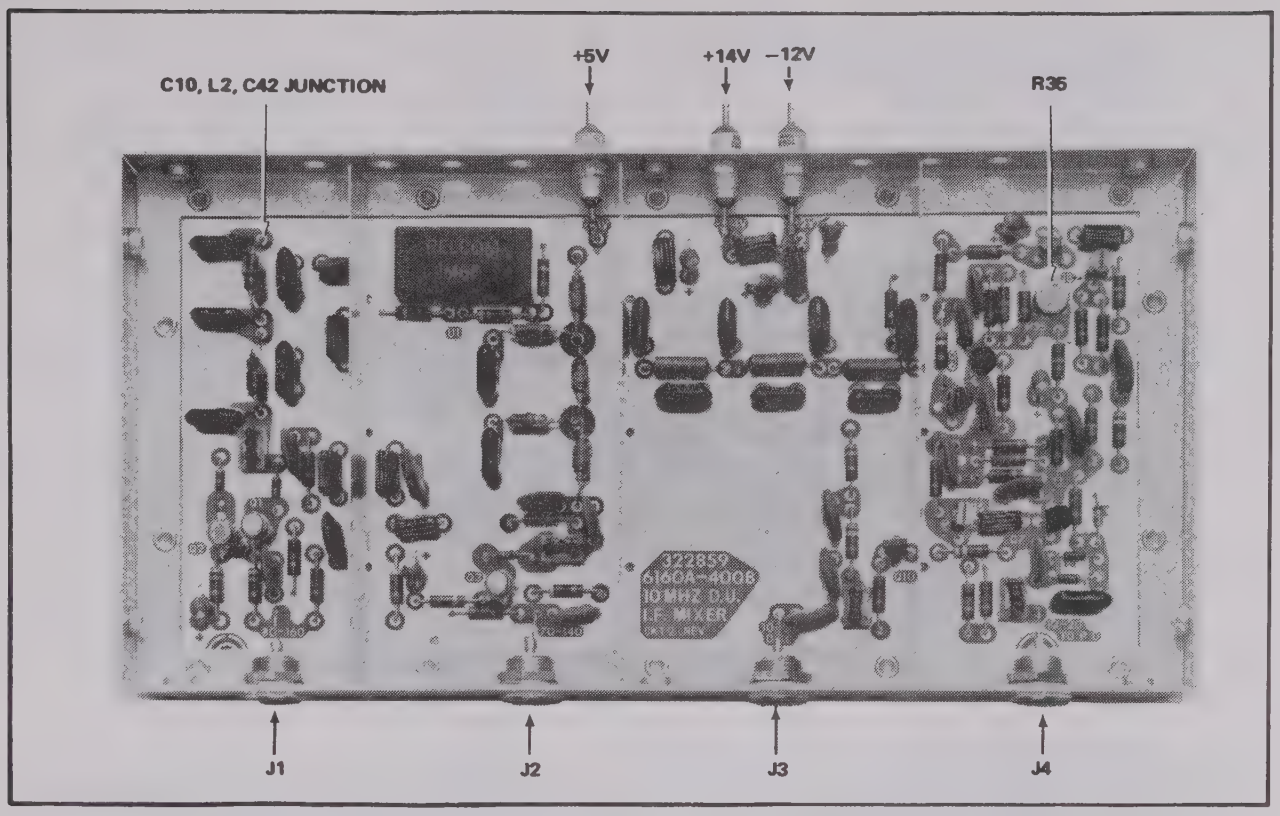



Figure 4-17. ADJUSTMENT, TEST POINT, INPUT/OUTPUT CONNECTOR LOCATIONS (6160A-4108)

e. Connect a 50 ohm load to J3.

f. Connect the input of an rf voltmeter together with a 50 ohm load to J4.

g. Adjust R35 for a −7.7 dbm ±0.2 db output at J4.

h. Connect rf voltmeter together with 50 ohm load to J3 and connect 50 ohm load to J4. The output at J3 should be −5 dbm ±1 db.

i. Repeat steps e and f.

j. Perform the output level checks in Table 4-10.

k. Disconnect signal generator from J2.

Table 4-10. OUTPUT LEVEL CHECKS

| J1 | | J2 | | J4 OUTPUT |
|---|---|---|---|---|
| FREQ (MHz) | LEVEL (dbm) | FREQ (MHz) | LEVEL (dbm) | LEVEL (dbm) |
| 150 | +5±2 | 140 | −9±0.5 | >−14.5 |
| 160 | +5±2 | 140 | −9±0.5 | >−14.5 |
| 172 | +5±2 | 140 | +1±0.5 | >-20 |
| 157 | +5±2 | 120 | +1±0.5 | <−40 |

l. Connect rf voltmeter via rf probe to junction of C10, L2, C42.

m. Perfrom the signal level checks in Table 4-11.

Table 4-11. SIGNAL LEVEL CHECKS

| J1 | | SIGNAL LEVEL (dbm) |
|---|---|---|
| FREQ (MHz) | LEVEL (DBM) | (Junction C10, L2, C42) |
| 169 | +2±0.5 | +9±2 |
| 120 | +2±0.5 | +9±2 |
| 80 | +2±0.5 | +9±2 |

n. Disconnect test equipment and replace module cover.

## 4-73. 10 MHz Main Loop VCO (6160A-4110)

4-74. This module is removed from the synthesizer and aligned with the following equipment.

a. Power Supply.

b. Signal Generator.

c. RF Voltmeter (with rf probe).

d. Digital Voltmeter.

e. Frequency Counter.

f. 50 ohm load.

g. 33k, ¼W Resistor.

h. 39k, ¼W Resistor.

i. 130Ω, ¼W Resistor.

4-75. Figure 4-18 shows adjustment, test point and input/output connector locations on the 10 MHz D.U. Main VCO module. Alignment is as follows:

a. Remove the cover from the module.

b. Apply a 10 MHz signal having a level of 200 ±20 mV to TP3.

c. Connect the input of an rf voltmeter (probe) to TP4. Connect probe ground lead to TP2.

d. Adjust C8 for minimum rms voltage at TP3 (less than 2 mV).

e. Tune the signal generator from 10 to 19 MHz, observing that the rms voltage at TP3 does not exceed 15 mV.

f. Disconnect the signal generator and rf voltmeter from the module.

g. Apply dc voltages (+5V, +14V, −12V) to the appropriate feed-thru connectors on the module. Connect power supply common to the module chassis.

h. Jumper "4" and "1" feed-thru connectors to ground.

i. Connect a 130Ω, ¼W resistor between J1 and

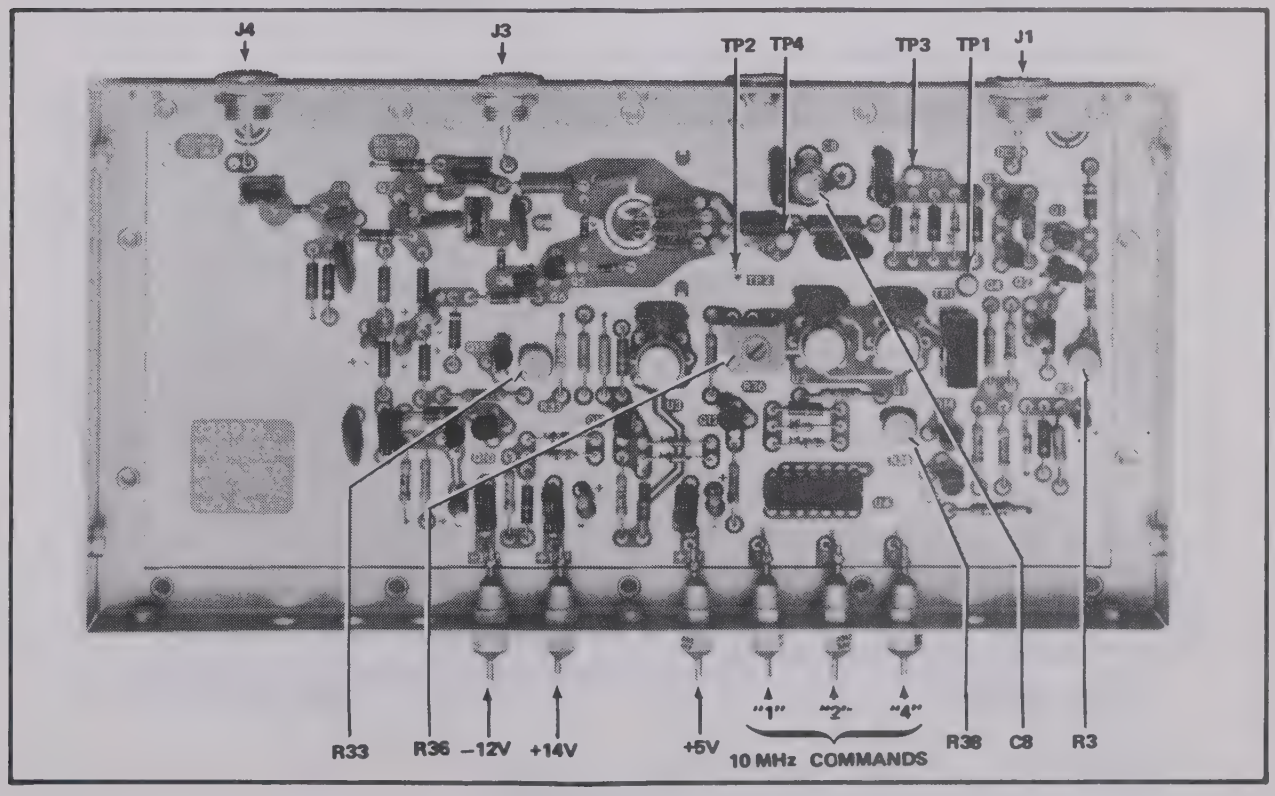



Figure 4-18. ADJUSTMENT, TEST POINT, INPUT/OUTPUT CONNECTOR LOCATIONS (6160A-4110)

j. Connect the rf voltmeter together with a 50 ohm load to J3.

k. Connect the input of a frequency counter to J4.

l. Connect the input of a digital voltmeter to TP (+) and TP2 (–).

m. Adjust R3 such that voltage at TP1 transitions between lower and upper levels. This can also be observed via the frequency counter connected to J4.

n. Connect the digital voltmeter input (+) to J1, observing that the voltage is 0 ±10 mVdc.

o. Repeat steps 1 thru n until results are obtained without further adjustment.

p. Connect the digital voltmeter to TP1 (+) and TP2 (–).

q. Apply –12 Vdc via a 33k, ¼W resistor to J1 and jumper "4", "2" "1" feed-thru connectors to ground.

r. Adjust R33 for a 75 MHz +0/–200 kHz output at J4. The voltage at TP1 should be greater than +0.5 Vdc.

s. Apply +14 Vdc via a 39k, ¼W resistor to J1 and then adjust R38 for a 96 MHz +100 kHz output at J4.

t. Disconnect jumpers from "4", "2", "1" feed-thru connectors and then adjust R36 for a 165 MHz +200 kHz/–0 output at J4. The voltage at TP1 should be less than +11.5 Vdc.

*NOTE!*

*If voltage at TP1 is not within limits, change length of coils (L11 and L12). Longer coils yield higher voltage. Shorter coils decrease voltage.*

u. Perform the frequency tracking checks in Table 4-12. Adjust, as necessary, R33, R38 and R36 per Table 4-13 until tracking limits are met.

v. Disconnect frequency counter from J4.

Table 4-12. FREQUENCY TRACKING CHECKS

| J1 INPUT ①= 33k, 1/4w ②= 39k, 1/4w | GROUND JUMPERS | OUTPUT FREQ. J4 (MHz) |
|---|---|---|
| –12V via ① | 4, 2, 1 | 65 to 75 |
| +14V via ② | 4, 2, 1 | 95 to 99 |
| –12V via ① | 4, 2 | 75 to 85 |
| +14V via ② | 4, 2 | 105 to 109 |
| –12V via ① | 4, 1 | 85 to 95 |
| +14V via ② | 4, 1 | 115 to 119 |
| –12V via ① | 4 | 95 to 105 |
| +14V via ② | 4 | 125 to 129 |
| –12V via ① | 2, 1 | 105 to 115 |
| +14V via ② | 2, 1 | 135 to 139 |
| –12V via ① | 2 | 115 to 125 |
| +14V via ② | 2 | 145 to 149 |
| –12V via ① | 1 | 125 to 135 |
| +14V via ② | 1 | 155 to 159 |
| –12V via ① | NONE | 135 to 145 |
| +14V via ② | NONE | 165 to 169 |
| NOTE: Ensure 130Ω, 1/4w resistor is connected from J1 to ground. | | |

Table 4-13. TRACKING LIMIT ADJUSTMENTS

| ADJUSTMENT | AFFECT |
|---|---|
| R33 | Changes low frequency (–12V input to J1) |
| R38 | Changes high frequency (+14V input to J1) |
| R36 | Changes maximum frequency (+14V input to J1) |

w. Apply –12 Vdc via a 33k, ¼W resistor to J1 and jumper the following feed-thru connectors to ground, observing that the output signal at J3 is +1.5 dbm ±1.5 db.

| Feed-Thru |
|---|
| "4", "2", "1" |
| "4", "2" |
| "4", "1" |
| "4" |

x. Apply +14 Vdc via a 39k, ¼W resistor to J1, and jumper the following feed-thru connectors to ground, observing that the output signal at J3 is +1.5 dbm ±1.5 db.

| Feed-Thru |
|---|
| "2", "1" |
| "2" |
| "1" |
| NONE |

y. Connect the rf voltmeter together with a 50 ohm load to J4 and repeat steps w, and x, observing that the output signal at J4 is +4 dbm ±1.5 db.

z. Disconnect test equipment and replace module cover.

## 4-76. Output Divider (6160A-4111)

4-77. Alignment of this module is done in the synthesizer using the following equipment:

a. Spectrum Analyzer.

b. Counter.

c. Signal Generator.

d. RF Voltmeter.

e. 6 db Pad.

4-78. Figure 4-19 shows adjustment, test point, and input/output connector locations for this module. Alignment of this module is as follows:

a. Remove module enclosure cover.

b. Connect 4110 OUT (J3) to a 6 db pad. Connect output of 6 db pad to –4111 INPUT (J4).

c. Connect counter through 50 ohm cable to RF OUTPUT connector on front panel. Terminate-counter input with 50 ohm load.

d. Set front panel controls as follows:

| | |
|---|---|
| Frequency Dials | 150.000000 |
| FUNCTION | 10 – 160 MHz |
| OUTPUT LEVEL | Midposition |

e. Remove connections to J1 and J3 on –4109 module. Apply power to Model 6160A.

f. Note the frequency on the counter. (This frequency is referenced as $f_1$, in Table 4-14. Perform steps 1 through 6 in Table 4-14 and note frequency on counter.

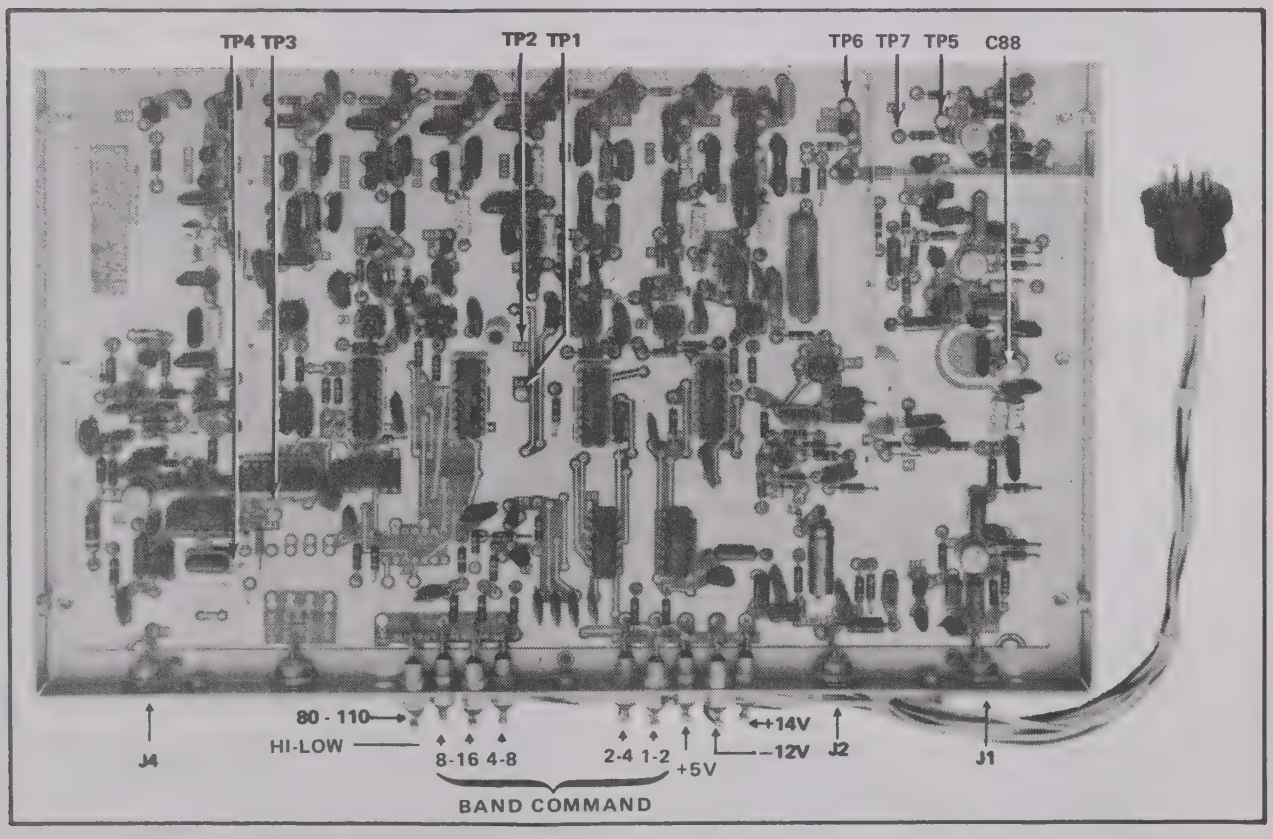



Figure 4-19. ADJUSTMENT, TEST POINT, INPUT/OUTPUT CONNECTOR LOCATIONS (6160A-4111)

Table 4-14. OUTPUT DIVIDER CHECKS

| STEP NO. | FRONT PANEL DIAL SETTING | COUNTER FREQUENCY |
|---|---|---|
| 1 | 79.000000 | $f_1/2$ |
| 2 | 39.000000 | $f_1/4$ |
| 3 | 19.000000 | $f_1/8$ |
| 4 | 07.900000 | $f_1/20$ |
| 5 | 03.900000 | $f_1/40$ |
| 6 | 01.900000 | $f_1/80$ |

Table 4-15. OUTPUT DIVIDER LEVEL CHECKS

| STEP NO. | MHz DIAL CONTROLS | RF VOLTMETER INDICATION |
|---|---|---|
| 1 | 1.00 to 1.99 in 100 kHz steps | +14 dbm ±.5 db |
| 2 | 2.00 to 3.99 in 100 kHz steps | |
| 3 | 4.00 to 7.99 in 1 MHz steps | |
| 4 | 8.00 to 11.99 in 1 MHz steps | |
| 5 | 10.00 to 19.99 in 1 MHz steps | |
| 6 | 20.00 to 39.99 in 1 MHz steps | |
| 7 | 40.00 to 79.99 in 10 MHz steps | |
| 8 | 80.00 to 159.99 in 10 MHz steps | |

g. Set front panel frequency dials to 110.000000 MHz and note frequency on counter. (This frequency will be referenced as $f_2$).

h. Set front panel frequency dials to 11.000000 MHz. The frequency on the counter must equal $f_2/10$.

i. Remove 6 db pad and connect signal generator to –4111 INPUT (J4).

j. Connect spectrum analyzer to RF OUTPUT connector on front panel.

k. Set front panel frequency dials to 150.000000 and set signal generator to 206.5 MHz at 0 dbm.

l. Adjust C88 for a minimum indication of 206.5 MHz on spectrum analyzer.

m. Install module enclosure covers. Install J1 and J3 connections to the –4109 module and connect –4110 OUTPUT (J3) directly to –4111 INPUT (J4).

## 4-79. Front Panel PCB Assembly (6160A-4051)

4-80. Use the following equipment for adjustment of the Front Panel PCB Assembly.

a. RF Voltmeter.

b. Compensated 50 ohm In-Line Adaptor for RF Voltmeter.

4-81. Figure 4-4 shows adjustment locations on the Front Panel PCB Assembly. Use the following procedure for adjusting this pcb assembly.

a. Connect rf voltmeter through 50 ohm in-line load to RF OUTPUT connector on front panel.

b. Set OUTPUT LEVEL control to +13 dbm position.

c. Set FUNCTION switch 10-160 MHz and frequency dials to 10.000000 MHz.

d. Adjust R4 (refer to Figure 4-4 for location) for +13 dbm ±1 db indication on rf voltmeter.

e. Rotate most significant decade dial from position 1 to 15 and observe that rf voltmeter indication is +13 dbm ± 1 db. Readjust R4 if necessary.

f. Set FUNCTION switch to 1-12 MHz and rotate most significant decade dial from position 1 to 12. RF Voltmeter should indicate +13 dbm ±1 db If readjustment of R4 is necessary, recheck step d with FUNCTION switch set to 10–160 MHz.

g. Set OUTPUT LEVEL control to +3 dbm position, set FUNCTION switch to 10–160 MHz and frequency dials to 10.000000.

h. Adjust R6 (Refer to Figure 4-4 for location) for +3 dbm ±1 db.

i. Rotate most significant decade dial from positions 1 to 15 observing that rf voltmeter indicates +3 dbm ±1 db. Readjust R6 if necessary.

j. Set FUNCTION switch to 1-12 MHz and rotate most significant decade dial from positions 1 to 12. Observe that rf voltmeter indicates +3 dbm. If readjustment of R6 is necessary, repeat step h with FUNCTION switch set to 10-160 MHz.

k. Remove all test equipment.

## 4-82. TROUBLESHOOTING

4-83. Troubleshooting of the Model 6160B can be catagorized into two separate conditions: (1) Catastrophic, where no outputs (Buffered 5 MHz output or 1 - 160 MHz output) are present, (2) Synthesizing errors, where incorrect output frequencies are obtained. The first malfunction can usually be attributed to a power supply problem. Isolation of a synthesizing error, however, is somewhat more difficult and may require a thorough understanding of the synthesizer block diagram. It is, therefore, recommended that the contents of Section 3 be read. Input/output connectors, testpoint, and adjustment locations for each module or assembly can be found in the alignment section for each module or assembly. In addition, Table 4-16 lists dialed frequencies with corresponding computer output commands and output frequencies from the Six Digit Generator, 1 MHz Generator, and 10 MHz Generator.

4-84. Figure 4-20 shows assembly locations of each assembly and module referred to in the troubleshooting chart (Drawing No. 6160B-1600). Drawing No. 6160B-1600, located in the schematic section of this manual, is a troubleshooting chart for the Model 6160B with the –02, –04, or –05 options. Synthesis OK implies the frequency is synthesized at the desired frequency. All frequencies in Drawing No. 6160B-1600 are in MHz and are measured without disrupting the path by utilizing the JF 207092 and 707100 adaptors, spare cable, BNC Tee, and high impedance counter. Always check for proper supply and command voltages as well as rf input signals at the suspected module before removal and disassembly of the module. Table 4-17 lists expected output levels at various interface points. Signal levels are typical values and may vary several db between instruments. Level measurements are made without disrupting the signal path by utilizing the JF207092 and 207100 adaptors, spare cable, and BNC-to-scope adaptor contained in the service kit (6160A-7006). Coax line length must be kept at a minimum for the Tee to scope probe.

Table 4-16. COMPUTER OUTPUT COMMANDS

| DIALED FREQUENCY MHz | COMPUTER OUTPUT DIGITAL COMMANDS TO EACH DECADE | | | | | | | | SIX DIGIT GENERATOR OUTPUT FREQUENCY MHZ (6040A-4102,J2) | 1 MHz DIGIT GENERATOR OUTPUT FREQUENCY MHz (6160B-4153-2, J1) | 10 MHz DIGIT GENERATOR OUTPUT FREQUENCY MHz (6160A-4110, J3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 MHz | 1 MHz | 100 kHz | 10 kHz | 1 kHz | 100 Hz | 10 Hz | 1 Hz | | | |
| 10-160 MHz RANGE | | | | | | | | | | | |
| 80.000000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20.00000 | 10.000000 | 80.000000 |
| 81.111111 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 22.22222 | 11.111111 | 81.111111 |
| 82.222222 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 24.44444 | 12.222222 | 82.222222 |
| 93.333333 | 1 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 26.66666 | 13.333333 | 93.333333 |
| 104.444444 | 2 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 28.88888 | 14.444444 | 104.444444 |
| 115.555555 | 3 | 11 | 1 | 1 | 1 | 1 | 1 | 0 | 21.11110 | 15.555555 | 115.555555 |
| 126.666666 | 4 | 13 | 3 | 3 | 3 | 3 | 3 | 2 | 23.33332 | 16.666666 | 126.666666 |
| 137.777777 | 5 | 15 | 5 | 5 | 5 | 5 | 5 | 4 | 25.55554 | 17.777777 | 137.777777 |
| 148.888888 | 6 | 17 | 7 | 7 | 7 | 7 | 7 | 6 | 27.77776 | 18.888888 | 148.888888 |
| 159.999999 | 7 | 19 | 9 | 9 | 9 | 9 | 9 | 8 | 29.99998 | 19.999999 | 159.999999 |
| 10.875000 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 20.00000 | 17.000000 | 87.000000 |
| 30.875000 | 4 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 20.00000 | 13.500000 | 123.500000 |
| 40.875000 | 0 | 3 | 5 | 0 | 0 | 0 | 0 | 0 | 25.00000 | 11.750000 | 81.750000 |
| 80.650000 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 23.00000 | 10.650000 | 80.650000 |
| 20.650000 | 0 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 22.00000 | 12.600000 | 82.600000 |
| 19.500000 | 7 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 20.00000 | 16.000000 | 156.000000 |
| 39.500000 | 7 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 20.00000 | 18.000000 | 158.000000 |
| 79.500000 | 7 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 20.00000 | 19.000000 | 159.000000 |
| 42.250000 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 20.00000 | 14.500000 | 84.500000 |
| 125.250000 | 4 | 10 | 5 | 0 | 0 | 0 | 0 | 0 | 25.00000 | 15.250000 | 125.250000 |
| 1-12 MHz RANGE | | | | | | | | | | | |
| 1.9990000 | 7 | 19 | 8 | 4 | 0 | 0 | 0 | 0 | 28.40000 | 19.920000 | 159.920000 |
| 3.9990000 | 7 | 19 | 9 | 2 | 0 | 0 | 0 | 0 | 29.20000 | 19.960000 | 159.960000 |
| 7.9247500 | 7 | 16 | 9 | 9 | 0 | 0 | 0 | 0 | 29.90000 | 18.550000 | 158.550000 |
| 8.0004997 | 0 | 0 | 0 | 0 | 9 | 9 | 9 | 8 | 20.09998 | 10.004999 | 80.004999 |

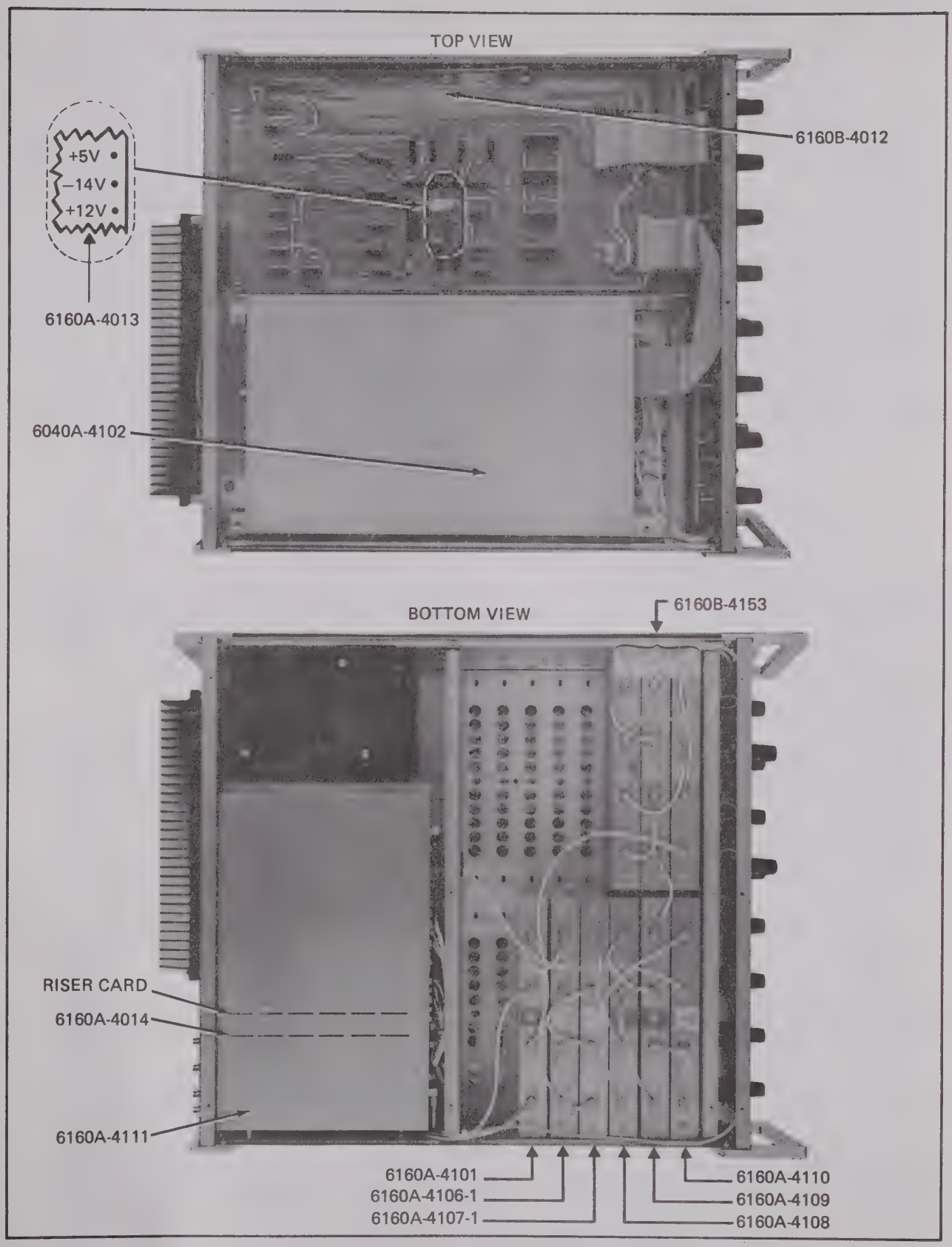
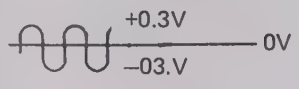
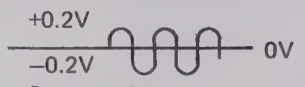
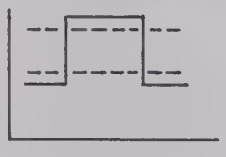



Figure 4-20. MODEL 6160B ASSEMBLY LOCATIONS

Table 4-17. INTERFACE LEVEL

| MODULE | JACK | LEVEL |
|---|---|---|
| 4101 INPUT FILTER | J2<br>J3<br>J4 | TTL<br>2V rms open CKT<br>2V p-p sine wave |
| 4102 6-DIGIT GENERATOR | J3<br>J2 | TTL<br>TTL |
| 4153-2 1 MHz DIGIT GENERATOR MODULE SET | J1 |  |
| 4106-1 10 MHz STEP LOOP PHASE DETECTOR | J2<br>J3 | <±0.01 VDC<br>0.1V ±0.1V or 0.7V |
| 4107-1 10 MHz STEP LOOP VCO | J3<br>J4 | 250 mV rms sine wave<br>300 mV rms sine wave |
| 4108 10 MHz IF MIXER | J3<br><br>J4 |  <br>Same as above |
| 4109 10 MHz MAIN LOOP PHASE DETECTOR | J2 | DC Voltage < ±0.4V |
| 4110 10 MHz MAIN LOOP VCO | J3<br>J4 | 0.3V rms sine wave<br>0.3V rms sine wave |
| 4111 OUTPUT DIVIDER | J1 | 1V rms with 1-160 MHz output terminated into 50Ω |
| NOTE:<br>TTL= | | 2.1V<br>0.9V<br>0V<br>  |

4-85. Reference to Note A, B, C, or D in Drawing No. 6160B-1600, refers to the following notes:

*NOTE A!*

*The –12V supply is used as a reference for the +14 and +5V supplies, therefore, a malfunction on the –12V supplies will make the +14V and +5V supplies inoperative.*

*NOTE B!*

*Isolation of 4106-1 and 4107-1 problems. A signal at 4107-1J4 that is more than ±3MHz from the desired frequency indicates a failure of the 4107-1 module. If the error is less than ±2MHz the 4106-1 module is probably at fault. Remove connection to 4107-1J1 and check for the best (error frequency) signal of 30 - 50 mV p-p into 50 ohm and less than 1.5MVdc offset coming from the 4106-1 module. If no beat is present, there is a definite failure of the 4106-1 module. If the beat is present, continue with the following two-step test.*

*a. Shunt 4107-1J1 with a 120 ohm resistor and remove connection to 4107-1J2. Load this port with a 1 kilohm load. Insert +40μA into J1, (use a 0.35 resistor to +14V supply). Check that frequency at 4107-1J4 is 1.7 to 3.3MHz above desired frequency and that approximately minus 1.5 to –1.8V is across the 1 kilohm load at 4107-1J2.*

*b. With resistors installed as in step A., pull minus 40 Ma from 4107-1J1, (use 0.3 resistor to –12V supply). Check 4107-1J4 frequency. It must be 1.7 to 3.3 MHz below desired frequency and indicate from +1.0 to +1.2V across the load resistor on 4107-1J2. If conditions described in steps A. and B. are not met the 4107-1 Module is defective. If these conditions are met, the 4106-1 is faulty. The following table, (Table 4-18) indicates desired 4107-1J4 Frequency vs. 10MHz Dial Position.*

Table 4-18. 6160A-4107–1, J4 FREQUENCY

| DIAL | FREQUENCY |
|---|---|
| 8 | 70 MHz |
| 9 | 80 MHz |
| 10 | 90 MHz |
| 11 | 100 MHz |
| 12 | 110 MHz |
| 13 | 120 MHz |
| 14 | 130 MHz |
| 15 | 140 MHz |

*NOTE C!*

*Vary the digit indicated by X and check for synthesis at each position of this switch in the case of all digits except the 10MHz digit. For the 10MHz digit range from 8 to 15.*

*NOTE D!*

*Isolation of 4109 and 4110 troubles. Open connection to 4110-J1. Voltage at J1 must be less than ±0.4V. Apply 1.4mA with a 10 kilohm resistor from the +14V supply into 4110-J1. Frequency at 4110-J3 must be higher than the 10MHz dial setting by 15MHz. Remove resistor to +14V supply and connect to –12V supply to draw 1.2mA from 4110-J1. Frequency at 4110-J3 must be lower than 10MHz dial setting by 5MHz. If these conditions are not met the fault is in the 4110 module. If these conditions are met, the fault is likely in the 4109 Module.*

4-86. The following tables (Table 4-19 and Table 4-20) list the voltage present on C1, C2, C3, and J13 of the –4013 Mother Board assembly referenced in Drawing No. 6160B-1600.

Table 4-19. J13, AC VOLTAGES

| PIN | AC VOLTAGE | PIN | AC VOLTAGE |
|---|---|---|---|
| 1 | 0 | A | (1) 0 |
| 2 | 0 | B | 0 |
| 3 | 19.7 ±15% | C | 19.7 ±15% |
| 4 | 0 | D | 0 |
| 5 | 0 | E | 0 |
| 6 | 19.7 ±15% | F | 19.7 ±15% |
| 7 | 9.9 | H | 9.9 |
| 8 | 9.9 | J | 9.9 |
| 9 | 9.9 | K | 9.9 |
| 10 | 9.9 | L | 9.9 |

NOTE: Gain access to J13 by removing top cover and hinging up 4102 module after removing the four screws securing it to synthesizer.

Table 4-20. UNREGULATED SUPPLY VOLTAGES

| TEST POINT | VDC |
|---|---|
| C3 (+) terminal | +25.2 ±15% |
| C2 (–) terminal | –25.4 ±15% |
| C1 (+) terminal | +11.7 ±15% |

NOTE: Gain access to test points by removing top cover and hinging up the 4102 module after removing the four screws securing it to the synthesizer.

# Section 5
# Lists of Replaceable Parts

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LIST OF REPLACEABLE PARTS, *continued*


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## 5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. Components are listed alphanumerically by assembly. Electrical components are listed by item number. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

a. Reference Designation or Item Number.
b. Description of each part.
c. Fluke Stock Number.
d. Federal Supply Code for Manufacturers. (See Appendix A for Code-to-Name list.)
e. Manufacturer's Part Number or Type.
f. Total Quantity per assembly of component.
g. Recommended Quantity: This entry indicates the recommending number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one in each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc. that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.
h. Use Code is provided to identify certain parts that have been added, deleted or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity, paragraph 5-7.

## 5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information:

a. Quantity.
b. FLUKE Stock Number.
c. Description.
d. Reference Designation or Item Number.
e. Printed Circuit Board Part Number.
f. Instrument Model and Serial Number.

## 5-7. USE CODE EFFECTIVITY LIST

| USE CODE | SERIAL NUMBER EFFECTIVITY |
|---|---|

## FINAL ASSEMBLY

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| | **6160B INSTRUCTION MANUAL** | 382028 | 89536 | 382028 | 1 | | |
| | **FREQUENCY SYNTHESIZER FINAL ASSEMBLY** **Figure 5-1 Sheets 1, 2, 3** | 6160B | 89536 | – | | | |
| A1 | Front Panel Assembly 6160B-4451 | 356519 | 89536 | 356519 | 1 | | |
| A2 | 10 MHz Main Loop VCO Module Assembly 6160A-4110 | 323741 | 89536 | 323741 | 1 | | |
| A3 | 10 MHz Main Loop Phase Detector Module Assembly 6160A-4109 | 323733 | 89536 | 323733 | 1 | | |
| A4 | 10 MHz IF Mixer Module Assembly 6160A-4108 | 323725 | 89536 | 323725 | 1 | | |
| A5 | 10 MHz Step Loop VCO Module Assembly 6160A-4107-1 | 341545 | 89536 | 341545 | 1 | | |
| A6 | 10 MHz Step Loop Phase Detector Module Assembly 6160A-4106-1 | 341537 | 89536 | 341537 | 1 | | |
| A7 | Input Filter Module Assembly 6160A-4101 | 323667 | 89536 | 323667 | 1 | | |
| A8 | 1 MHz Digit Generator Module Set 6160B-4153 | 356444 | 89536 | 356444 | 1 | | |
| A9 | Six Digit Generator Module Assembly 6040A-4102 | 367094 | 89536 | 367094 | 1 | | |
| A10 | Computer PCB Assembly 6160B-4012 | 356287 | 89536 | 356287 | 1 | | |
| A11 | Output Divider Module Assembly 6160A-4111 | 323758 | 89536 | 323758 | 1 | | |
| A12 | Power Supply PCB Assembly 6160A–4014 | 322933 | 89536 | 322933 | 1 | | |

## FINAL ASSEMBLY

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A13 | Mother Board PCB Assembly 6160B-4013 | 356295 | 89536 | 356295 | 1 | | |
| A14 | Riser Card, PCB 6160A-4015 | 323147 | 89536 | 323147 | 1 | | |
| A15 | Transformer Enclosure Assembly 6160A-4116 | 323493 | 89536 | 323493 | 1 | | |
| A16 | Heat Sink Assembly 6160A-4021 | 323154 | 89536 | 323154 | 1 | | |
| A17 | Rear Panel Assembly 6160A-4452 | 324616 | 89536 | 324616 | 1 | | |
| C1 | Cap, elect, 15,000 uf, 15V | 310367 | 06001 | 86F520 | 1 | | |
| C2, C3 | Cap, elect, 2900 uf, 40V | 325779 | 06001 | 86F555 | 2 | | |
| | *NOTE!* *The following items 1 through 8 can be found on Figure 5-1, Sheet 1 of 3.* | | | | | | |
| 1 | Cover, top | 323386 | 89536 | 323386 | 1 | | |
| 2 | Bottom cover | 323394 | 89536 | 323394 | 1 | | |
| 3 | Screw, 6 - 32 x ¼ FLH - Phillips, 82° undercut | 320093 | 73734 | Order by Description | 12 | | |
| 4 | Foot | 292870 | 89536 | 292870 | 4 | | |
| 5 | Screw, FLH-Phillips, #8 - 32 x 7/16 | 306159 | 73734 | 18265 | 4 | | |
| 6 | Decal, corner | 296277 | 89536 | 296277 | 4 | | |
| 7 | Decal, side trim | 295394 | 89536 | 295394 | 2 | | |
| 8 | Decal, handle trim | 295501 | 89536 | 295501 | 2 | | |
| | *NOTE!* *The following items 9 through 31 can be found in Figure 5-1, Sheet 2 of 3.* | | | | | | |

## FINAL ASSEMBLY

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| 9 | Bracket, card slide | 323287 | 89536 | 323287 | 1 | | |
| 10 | Bracket, support, Output Divider | 324582 | 89536 | 324582 | 1 | | |
| 11 | Bulkhead, center | 323253 | 89536 | 323253 | 1 | | |
| 12 | Bushing, snap, black nylon | 242164 | 28520 | SB-750-10 | 1 | | |
| 13 | Chassis Assembly | 356451 | 89536 | 356451 | 1 | | |
| 14 | Clamp, capacitor, elect | 185801 | 56289 | 4586-97A | 3 | | |
| 15 | Corner, rear | 295998 | 89536 | 295998 | 2 | | |
| 16 | End plate | 345538 | 89536 | 345538 | 1 | | |
| 17 | Nut, hex, 4 - 40 | 152819 | 78199 | 51106180000 | 3 | | |
| 18 | Screw, 4 - 40 x ¼ FLH - Phillips | 114884 | 73734 | 18222 | 2 | | |
| 19 | Screw, 4 - 40 x ¼ lock-type SEMS | 185918 | 73734 | Order by Description | 6 | | |
| 20 | Screw, 4 - 40 x 3/8 PNH - Phillips | 281196 | 73734 | 19024 | 27 | | |
| 21 | Screw, 6 - 32 x ¼, hex head | 347674 | 73734 | 5310 | 2 | | |
| 22 | Screw, 6 - 32 x ¼, FLH-Phillips 82° undercut | 268169 | 73734 | Order by Description | 4 | | |
| 23 | Screw, 6 - 32 x ¼, lock-type SEMS | 178533 | 73734 | Order by Description | 14 | | |
| 24 | Screw, 6 - 32 x 3/8 lock-type SEMS | 177022 | 73734 | Order by Description | 3 | | |
| 25 | Screw, 6 - 32 x 5/8 PNH - Phillips | 152181 | 73734 | 19047 | 3 | | |
| 26 | Screw, 8 - 32 x ¼ PNH - Phillips | 228890 | 73734 | 19063 | 2 | | |
| 27 | Screw, 8 - 32 x 3/8 FTH - Phillips | 114116 | 73734 | 18264 | 8 | | |
| 28 | Screw, 8 - 32 x ½ FTH - Phillips | 114355 | 73734 | 18266 | 10 | | |

## FINAL ASSEMBLY

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| 29 | Tie, cable | 172080 | 06383 | SST-1 | 1 | | |
| 30 | Washer, lock, internal #4 | 110403 | 73734 | 99402 | 18 | | |
| 31 | Washer, lock, external #6 | 169235 | 73734 | 1322 | 2 | | |
| | *NOTE!* *The following items 32 through 63 can be found in Figure 5-1, Sheet 3 of 3.* | | | | | | |
| 32 | Bracket, stiffener | 356311 | 89536 | 356311 | 1 | | |
| 33 | Bracket, hinge, left-hand | 356337 | 89536 | 356337 | 1 | | |
| 34 | Bracket, hinge, right-hand | 367466 | 89536 | 367466 | 1 | | |
| 35 | Cable –23, black | 367391 | 89536 | 367391 | 1 | | |
| 36 | Cable –16, violet | 367326 | 89536 | 367326 | 1 | | |
| 37 | Cable –15, red | 367318 | 89536 | 367318 | 1 | | |
| 38 | Cable –17, yellow | 367334 | 89536 | 367334 | 1 | | |
| 39 | Cable –22, brown | 367383 | 89536 | 367334 | 1 | | |
| 40 | Cable –21, orange | 367375 | 89536 | 367375 | 1 | | |
| 41 | Cable –20, blue | 367367 | 89536 | 367367 | 1 | | |
| 42 | Cable –19, green | 367359 | 89536 | 367359 | 1 | | |
| 43 | Cable –18, white | 367342 | 89536 | 367342 | 1 | | |
| 44 | Cable –12, violet | 367284 | 89536 | 367284 | 1 | | |
| 45 | Cable –13, yellow | 367292 | 89536 | 367292 | 1 | | |
| 46 | Cable –11, red | 367276 | 89536 | 367276 | 1 | | |
| 47 | Cable –14, green | 367300 | 89536 | 367300 | 1 | | |
| 48 | Cable –9, blue | 367250 | 89536 | 367250 | 1 | | |
| 49 | Cable –8, orange | 367243 | 89536 | 367243 | 1 | | |
| 50 | Clip, speed | 352666 | 78553 | C26053SS-020 | 1 | | |
| 51 | Foot, unit | 292870 | 89536 | 292870 | 4 | | |
| 52 | Screw, 8-32 x 7/16 FLH 82° undercut slotted | 306159 | 73734 | Order by Description | 4 | | |
| 53 | Nut, self-locking, KEP | 195255 | 78189 | 511-041800-00 | 2 | | |
| 54 | Screw, 4-40 x ¼ PNH - Phillips | 129890 | 73734 | 19022 | 1 | | |

## FINAL ASSEMBLY

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| 55 | Screw, 4 - 40 x 5/16 PNH - Phillips | 152116 | 73734 | 19023 | 6 | | |
| 56 | Screw, 6 - 32 x ¼ PNH - Phillips | 152140 | 73734 | 19042 | 6 | | |
| 57 | Screw, 6 - 32 x ¼, LK-Type, SEMS | 178553 | 73734 | Order by Description | 4 | | |
| 58 | Screw, 6 - 32 x 3/8, LK-Type, SEMS | 177022 | 73734 | Order by Description | 5 | | |
| 59 | Screw, 6 - 32 x 3/8 Hex Head | 329995 | 73734 | 5312 | 2 | | |
| 60 | Screw, 6-32 x ½, LK-Type, SEMS | 177030 | 73734 | Order by Description | 2 | | |
| 61 | Clamp, cable | 104638 | 06383 | SSC-2 | 2 | | |
| 62 | Washer, flat, fiberglass #4 | 145638 | 76854 | 2-1185-119 | 1 | | |
| 63 | Washer, fiber | 110684 | 83330 | 2166 | 1 | | |
| | *NOTE!* | | | | | | |
| | *The following items are not illustrated.* | | | | | | |
| | Cable, # 1 | 269969 | 89536 | 269969 | 1 | | |
| | Cable, # 2 | 259747 | 89536 | 259749 | 1 | | |
| | Cable, # 3 | 205831 | 89536 | 205831 | 1 | | |
| | Cable, # 4, 9, 10, 11, 12, 15, 19, 20, 21 | 205757 | 89536 | 205757 | 9 | | |
| | Cable, # 7 | 205880 | 89536 | 205880 | 1 | | |
| | Cable, # 8 | 270116 | 89536 | 270116 | 1 | | |
| | Cable, # 13, 14, 18 | 205765 | 89536 | 205765 | 3 | | |
| | Cable, # 16 | 205856 | 89536 | 205856 | 1 | | |
| | Cable, # 17 | 205799 | 89536 | 205799 | 1 | | |
| | Cable, # 22 | 269977 | 89536 | 269977 | 1 | | |
| | Cable, # 23 | 333096 | 89536 | 333096 | 1 | | |
| | Cable, # 24 | 270264 | 89536 | 270264 | 1 | | |
| | Cable, # 25 | 205773 | 89536 | 205773 | 1 | | |
| | Cable, # 26 | 259622 | 89536 | 259622 | 1 | | |
| | Chassis Assembly | 356451 | 89536 | 356451 | 1 | | |

## FINAL ASSEMBLY

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| | Screw, PNH, 6 - 32 x ¼ (Secures Computer PCB and Six-Digit Generator Module) | 152140 | 73734 | 19042 | 6 | | |
| | Accessory Kit | 324913 | 89536 | 324913 | 1 | | |

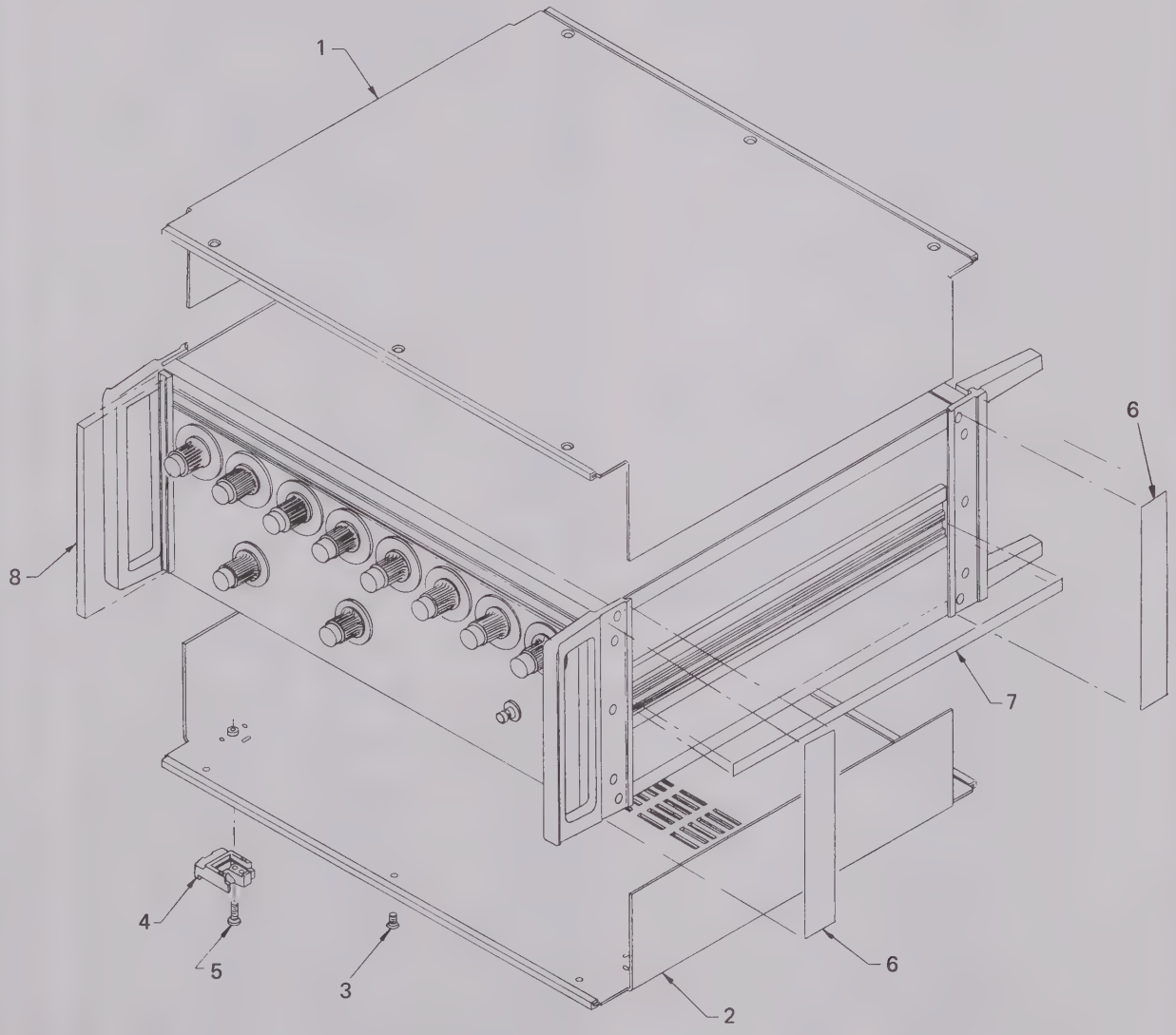


Figure 5-1. FINAL ASSEMBLY (Sheet 1 of 3)

# FINAL ASSEMBLY

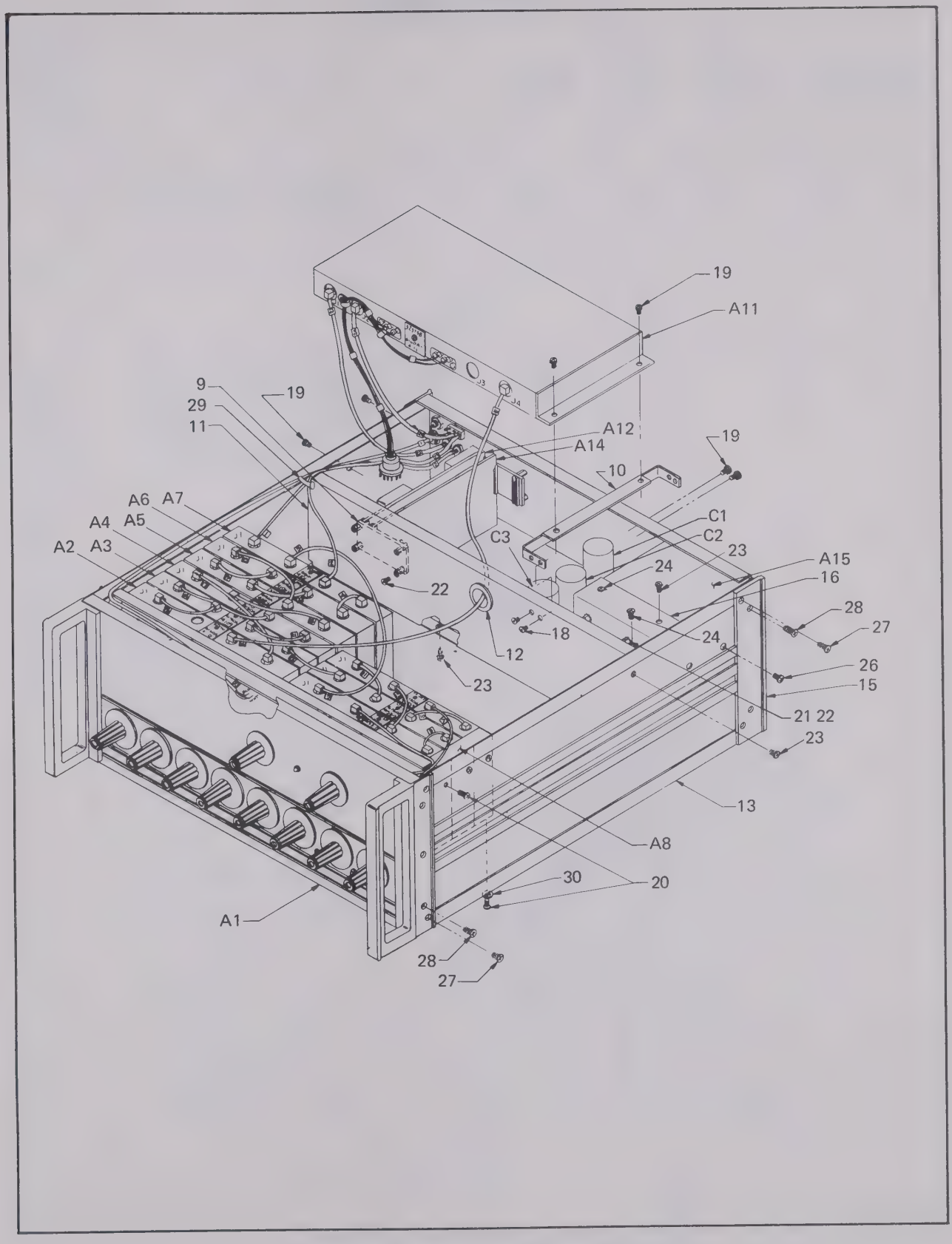


Figure 5-1. FINAL ASSEMBLY (Sheet 2 of 3)

## FINAL ASSEMBLY

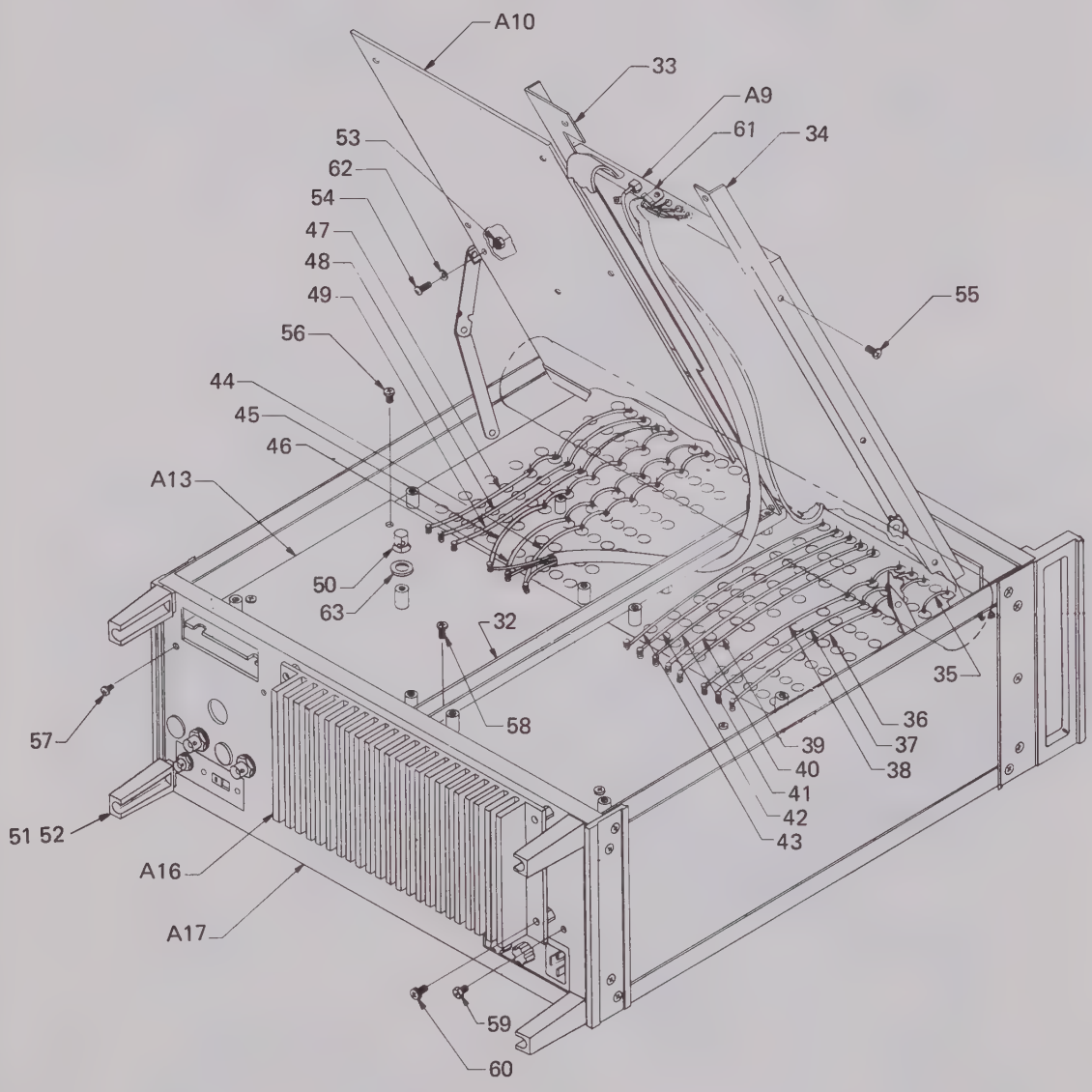


Figure 5-1. FINAL ASSEMBLY (Sheet 3 of 3)

## FRONT PANEL ASSEMBLY, A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A1 | **FRONT PANEL ASSEMBLY**<br>**Figure 5-2 6160B-4451** | 356519 | 89536 | 356519 | REF | | |
| A1A1 | Front Panel PCB Assembly | 323162 | 89536 | 323162 | 1 | | |
| A1A1 CR2 thru A1A1 CR13 | Diode, Ge, 80 mA, 100 piv<br>(Note: A1A1CR2 thru A1A1CR13 are located on Front Panel PCB Assembly, A1A1. When ordering A1A1 assembly, A1A1CR2 thru A1A1CR13 must be ordered separately) | 149187 | 98332 | 1N270 | 12 | 2 | |
| CR1 thru CR4 | Diode, light emitting | 309617 | 71318 | FLV102 | 4 | 1 | |
| A1A1 S1 thru A1A1 S3 | Switch, rotary<br>(Note: A1A1S1 thru A1A1S3 are located on Front Panel PCB Assembly, A1A1. When ordering A1A1 assembly, A1A1S1 thru A1A1S3 must be ordered separately) | 321091 | 89536 | 321091 | 3 | | |
| 1 | Bracket, corner angle | 329151 | 89536 | 329151 | 2 | | |
| 2 | Cable Assembly, rf output | 328534 | 89536 | 328534 | 1 | | |
| 3 | Clip, snap-in, with speed nut | 309625 | 07263 | FYC 001T | 4 | | |
| 6 | Handle, front corner | 295675 | 89536 | 295675 | 2 | | |
| 7 | Knob Assembly, 0-9 positions | 324863 | 89536 | 324863 | 7 | | |
| 8 | Knob Assembly, 1-15 positions | 324855 | 89536 | 324855 | 1 | | |
| 9 | Knob Assembly | 324848 | 89536 | 324848 | 2 | | |
| 10 | Name plate | 194183 | 89536 | 194183 | 1 | | |
| 11 | Nut, #6 hex | 110569 | 73734 | 8005 | 4 | | |
| 12 | Panel, screened front | 323188 | 89536 | 323188 | 1 | | |
| 13 | Screw, cap, #8 - 32 x 7/16 | 295105 | 74445 | 8-32 UNRC CLASS 3A | 4 | | |

## FRONT PANEL ASSEMBLY, A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| 14 | Screw, #4 - 40 x 3/16, FHD - Phillips | 293589 | 73734 | 4-40 x 3-16FHD /PHH BLK0X | 4 | | |
| 15 | Spacer, 1/8 in. | 215210 | 89536 | 215210 | 8 | | |
| 16 | Spacer, 3/16 in. | 103499 | 89536 | 103499 | 1 | | |
| 17 | Washer, internal lock | 110338 | 30323 | #6 | 4 | | |
| 18 | Nut, KEP, #6 - 32 | 152819 | 78199 | 51106180000 | 1 | | |

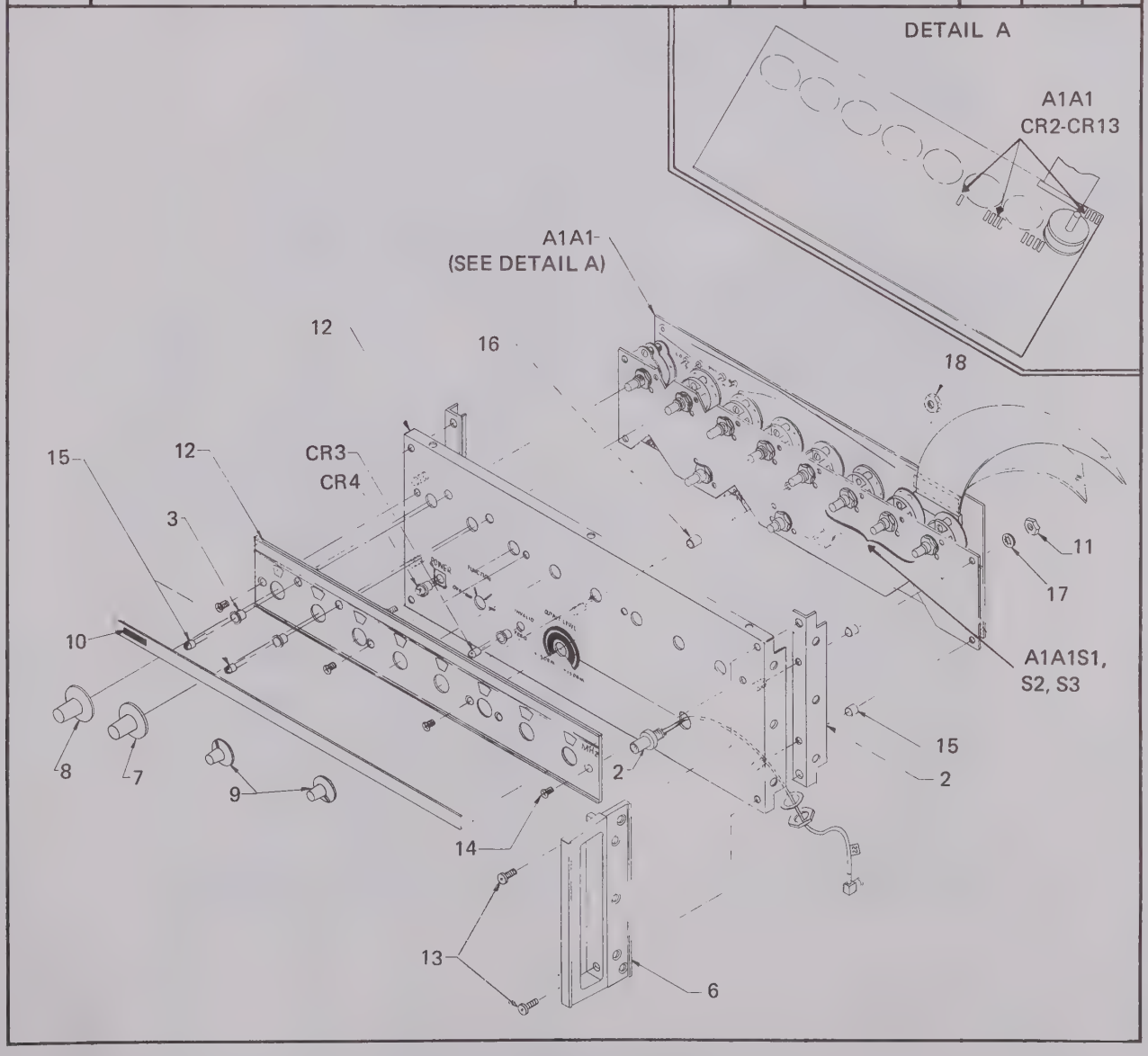


Figure 5-2 FRONT PANEL ASSEMBLY, A1

## FRONT PANEL PCB ASSEMBLY, A1A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A1A1 | **FRONT PANEL PCB ASSEMBLY**<br>**Figure 5-3 6160A-4051-03** | 323162 | 89536 | 323162 | 1 | | |
| C1 | Cap elect, 250 uf, +50/-10%, 16V | 187765 | 73445 | ET331X016A00 | 1 | | |
| CR1 | Not used | | | | | | |
| CR2 thru CR13 | **NOTE!**<br>*CR2 thru CR13 not included on this assembly. When ordering the A1A1 Assembly, these diodes must be ordered separately. Refer to A1A1 CR2 thru A1A1CR13 under A1 Front Panel Assembly parts list for part number.* | | | | | | |
| CR14 thru CR33 | Diode, germanium, 80 mA, 100 piv | 149187 | 93332 | 1N270 | 20 | | |
| J1,J2 | Connector, PCB to cable | 295337 | 35037 | Type 3402 | 1 | | |
| P1, P2 | Plug, cable to PCB (not illustrated) | 325910 | 35037 | 3424 | 2 | | |
| R1, R2 | Res, comp, 680Ω, ±5%, ¼W | 148007 | 01121 | CB6815 | 2 | | |
| R3 | Res, comp, 51Ω, ±5%, ¼W | 221879 | 01121 | CB5105 | 1 | | |
| R4 | Res, var, cermet, 5k, ±10%, ½W | 288282 | 71450 | 360S-502A | 1 | | |
| R5 | Res, comp, 6.2k, ±5%. ¼W | 221911 | 01121 | CB6225 | 1 | | |
| R6 | Res, var, cermet, 2k, ±10%. ½W | 285163 | 11236 | 360S-202A | 1 | | |
| R7 | Res, var, comp, 1k, ±5%, 2W | 255752 | 80294 | 3852A-281-102H | 1 | | |
| R8 | Res, comp, 3.9k, ±5%. ¼W | 148064 | 01121 | CB 3925 | 1 | | |
| R9, R10 | Res, comp, 330Ω, ±5%, ¼W | 147967 | 01121 | CB3315 | 2 | | |
| S1 thru S3 | **NOTE!**<br>*S1 thru S3 not included on this assembly. When ordering the A1A1 assembly, these switches must be ordered separately. Refer to A1A1S1 thru A1A1S3 under A1 Front Panel Assembly parts list for part number.* | | | | | | |
| S4 thru S7 | Switch, rotary, 10 position | 321091 | 89536 | 321091 | 4 | | |

## FRONT PANEL PCB ASSEMBLY, A1A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| S8 | Switch, rotary, 15 position | 321133 | 89536 | 321133 | 1 | | |
| S9 | Switch, rotary, 4 position | 321190 | 89536 | 321190 | 1 | | |
| U1 | IC, DTL, Quad-2 input nor gate | 320689 | 04713 | MC1811P | 1 | | |
| 1 | Cover, connector, J1 and J2 | 295329 | 35037 | TYPE 3402 | 2 | | |
| | Cable, flat | 291807 | 35037 | 3350 | 6 in | | |
| | Cable, flat | 291807 | 35037 | 3350 | 4 in | | |
| | Nut, hex, 3/8 x 32 | 110510 | 73734 | 3/8 -32NEF2B | 7 | | |
| | Plate, switch mounting | 323428 | 89536 | 323428 | 1 | | |
| | Washer, internal lock, 3/8 in. | 129957 | 78189 | 1220 - 05 | 7 | | |

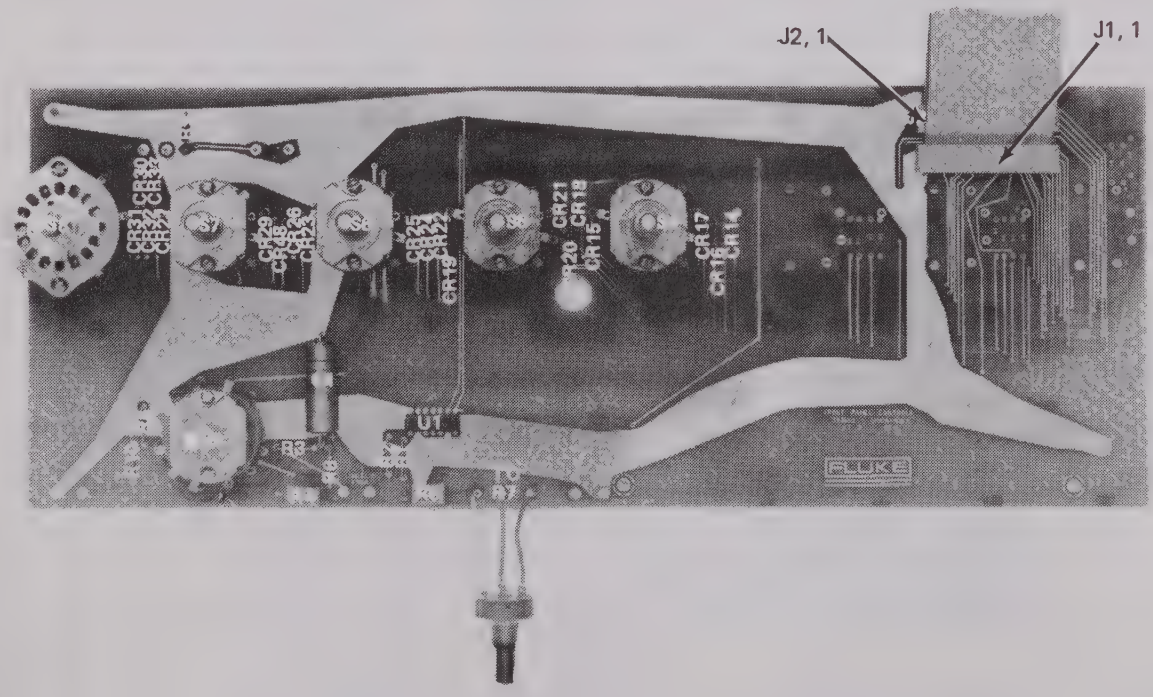


Figure 5-3. FRONT PANEL PCB ASSEMBLY, A1A1

## 10 MHz MAIN LOOP VCO MODULE ASSEMBLY, A2

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A2 | **10 MHz MAIN LOOP VCO MODULE ASSEMBLY**<br>**Figure 5-4 6160A-4110** | 323741 | 89536 | 323741 | REF | | |
| A2A1 | 10 MHz Main Loop VCO PCB Assembly | | | | 1 | | |
| 1 | Module Cover, inner | 323204 | 89536 | 323204 | 1 | | |
| 2 | Module cover, outer | 323212 | 89536 | 323211 | 1 | | |
| 3 | Screw, 4 - 40 x ¼ PNH - Phillips | 129890 | 73734 | 19022 | 7 | | |
| 4 | Nameplate | 329243 | 89536 | 329243 | 1 | | |

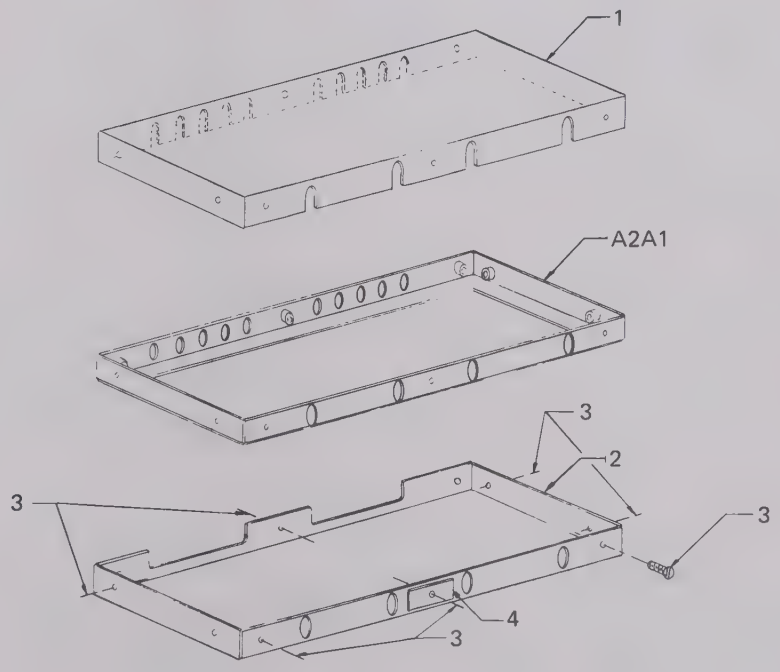


Figure 5-4. 10 MHz MAIN LOOP VCO MODULE ASSEMBLY, A2

## 10 MHz MAIN LOOP VCO PCB ASSEMBLY, A2A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A2A1 | **10 MHz MAIN LOOP VCO PCB ASSEMBLY**<br>**Figure 5-5 6160A-4010** | | | | REF | | |
| C1 thru C5, C12, C15, C17 | Cap, ta, 2.2 uf ±20%, 20V | 161927 | 56289 | 196D225X0020 | 8 | | |
| C6 | Cap, plstc, 0.033 uf ±10%, 50V | 271841 | 06001 | 75F1R5A334 | 1 | | |
| C8 | Cap, var cer, 4.5 to 50 pf + 70/-20%, 250V | 321117 | 73899 | DVJ305A | 1 | | |
| C9 | Cap, mica, 330 pf ±1%, 500V | 226142 | 53021 | D15F331F | 1 | | |
| C10 | Cap, mica, 39 pf ±5%, 500V | 148544 | 53021 | D15E390J | 1 | | |
| C11 | Cap, mica, 430 pf ±5%, 500V | 177980 | 53021 | D15F431J | 1 | | |
| C13, C16, C19 | Cap, cer, 0.05 uf +80/-20%, 25V | 148924 | 72982 | 5855-Y5U-5032 | 3 | | |
| C14, C18 | Cap, cer, 0.0012 uf ±10%, 500V | 106732 | 71590 | CF-122 | 2 | | |
| C20, C21, C22 | Cap, mica, 33 pf ±5%, 500V | 160317 | 53021 | D15E330J | 3 | | |
| C23 thru C28 | Cap, feed thru, 2500 pf, 500V | 248286 | 04222 | BSF-188 | 6 | | |
| CR1, CR2, CR3, CR8 thru CR13 | Diode, silicon, 150 mA | 203323 | 03508 | 1N4148 | 9 | 2 | |
| CR4 thru CR7 | Diode, tuning,hyper abrupt | 320200 | KEV Elec-tronics | TYPE KV 2001 | 4 | 1 | |

## 10 MHz MAIN LOOP VCO PCB ASSEMBLY, A2A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| J1, J2 J4 | Connector, male, coaxial | 207639 | 13511 | 27 - 875 | 3 | | |
| L1,L2 L3,L11 | Bead, 6 turn | 320911 | 89536 | 320911 | 4 | | |
| L5 | Inductor, 3.9 uh ±10%, 815 mA | 328054 | 24759 | MR3.9 | 1 | | |
| L6 | Bead, ferrite | 219535 | 02114 | 56-060-85-3B | 1 | | |
| L7 | Inductor, 1 uh ±10%, 2080 mA | 320952 | 24759 | MR1.0 | 1 | | |
| L8, L9 L10 | Inductor | 320903 | 89536 | 320903 | 3 | | |
| Q1, Q2, Q10 thru Q13 | Tstr, silicon, NPN | 218396 | 04713 | 2N3904 | 6 | 2 | |
| Q3, Q4 Q9, Q14, Q15 | Tstr, silicon, PNP | 195974 | 04713 | 2N3906 | 5 | 1 | |
| Q5, Q6, Q7, Q8 | Tstr, silicon, NPN | 248351 | 04713 | MPS918 | 4 | 1 | |
| R1 | Res, comp, 39Ω ±5%, ¼W | 193391 | 01121 | CB3905 | 1 | | |
| R2 | Res, met flm, 4.99k 1%, 1/8W | 168252 | 91637 | MFF1- 84-991F | 1 | | |
| R3, R38 | Res, var, cermet, 2k ±20%, ½W | 226076 | 19701 | ET50W202 | 2 | | |
| R4 | Res, comp, 6.8k ±5%, ¼W | 148098 | 01121 | CB6825 | 1 | | |
| R5,R6 | Res, met flm, 499Ω ±1%, 1/8W | 168211 | 91637 | MFF1-84990F | 2 | | |
| R7 | Res, met flm, 6.49k ±1%, 1/8W | 294900 | 91637 | MFF1-86-491F | 1 | | |
| R8, R23 | Res, comp, 2.7k ±5%, ¼W | 170720 | 01121 | CB2725 | 2 | | |
| R9 R21, R42, R48 | Res, comp, 100Ω ±5%, ¼W | 147926 | 01121 | CB1015 | 4 | | |
| R10, R11, R22 | Res, comp, 2.2k ±5%, ¼W | 148049 | 01121 | CB2225 | 3 | | |

## 10 MHz MAIN LOOP VCO PCB ASSEMBLY, A2A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R12, R13, R25 | Res, comp, 220Ω ±5%. ¼W | 147959 | 01121 | CB2215 | 3 | | |
| R14, R16, R19, R20 | Res, comp, 47Ω ±10%, 1/8W | 272211 | 01121 | BB4701 | 4 | | |
| R15 | Res, comp, 10Ω ±10%, 1/8W | 321125 | 01121 | BB1001 | 1 | | |
| R17, R18 | Res, comp, 470Ω ±5%, ¼W | 147983 | 01121 | CB4715 | 2 | | |
| R24 | Res, comp, 270Ω ±5%, ¼W | 160804 | 01121 | CB2715 | 1 | | |
| R26, R43, R44, R49 | Res, comp, 12k ±5%, ¼W | 159731 | 01121 | CB1235 | 4 | | |
| R27 | Res, met flm, 40.2k ±1%, 1/8W | 235333 | 91637 | MFF1-840-22F | 1 | | |
| R28 | Res, met flm, 20k ±1%, 1/8W | 291872 | 91637 | MFF1-82012F | 1 | | |
| R29 | Res, met flm, 10k ±1%, 1/8W | 168260 | 91637 | MFF1-81012F | 1 | | |
| R30, R31 | Res, met flm, 8.06k ±1%, 1/8W | 294942 | 91637 | MFF1-88061F | 2 | | |
| R32, R37 | Res, met flm, 4.22k ±1%, 1/8W | 168245 | 91637 | MFF1-844221F | 2 | | |
| R33 | Res, var, cermet, 10k ±20%, ½W | 226092 | 80294 | 3329H-1-103 | 1 | | |
| R34, R39 | Res, met flm, 24.9k ±1%, 1/8W | 291369 | 91637 | MFF1-82592F | 2 | | |
| R35 | Res, met flm, 3.01k ±1%, 1/8W | 312645 | 91637 | MFF1-83-011F | 1 | | |
| R36 | Res, var, cermet, 2k ±10%, ½W | 309666 | 11236 | 360T202A | 1 | | |
| R40, R41 | Res, met flm, 2k ±1%, 1/8W | 235226 | 91637 | MFF1-82001F | 2 | | |
| R45 | Res, met flm, 1k ±1%, 1/8W | 168229 | 91637 | MFF1-81001F | 1 | | |
| R46 | Res, met flm 23.2k ±1%, 1/8W | 291351 | 91637 | MFF1-82322K | 1 | | |
| R47 | Res, comp, 15k ±5%, ¼W | 148114 | 01121 | CB1535 | 1 | | |
| U1,U2 U3 | IC, Operational amplifier | 271502 | 12040 | LM301A | 3 | | 1 |
| U4 | IC, TTL, Hex inverter | 292979 | 01295 | 3N7404N | 1 | | 1 |

## 10 MHz MAIN LOOP VCO PCB ASSEMBLY, A2A1

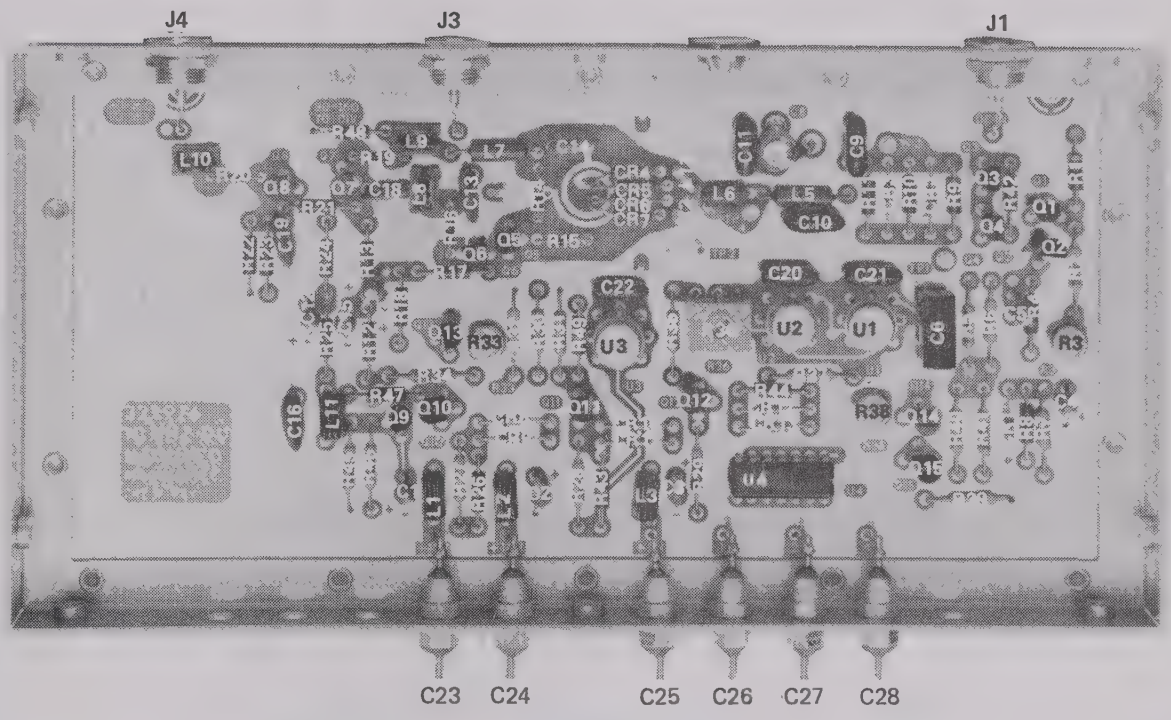


Figure 5-5. 10 MHz MAIN LOOP VCO PCB ASSEMBLY, A2A1

## 10 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY, A3

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A3 | **10 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY**<br>**Figure 5-6 6160A-4109** | 323733 | 89536 | 323733 | REF | | |
| A3A1 | 10 MHz Main Loop Phase Detector PCB Assembly<br>Figure | | | | 1 | | |
| 1 | Module Cover, inner | 323204 | 89536 | 323204 | 2 | | |
| 2 | Module Cover, outer | 323212 | 89536 | 323212 | 1 | | |
| 3 | Screw, 4 - 40 x ¼, PNH - Phillips | 129890 | 73734 | 19022 | 7 | | |
| 4 | Nameplate | 329235 | 89536 | 329235 | 1 | | |

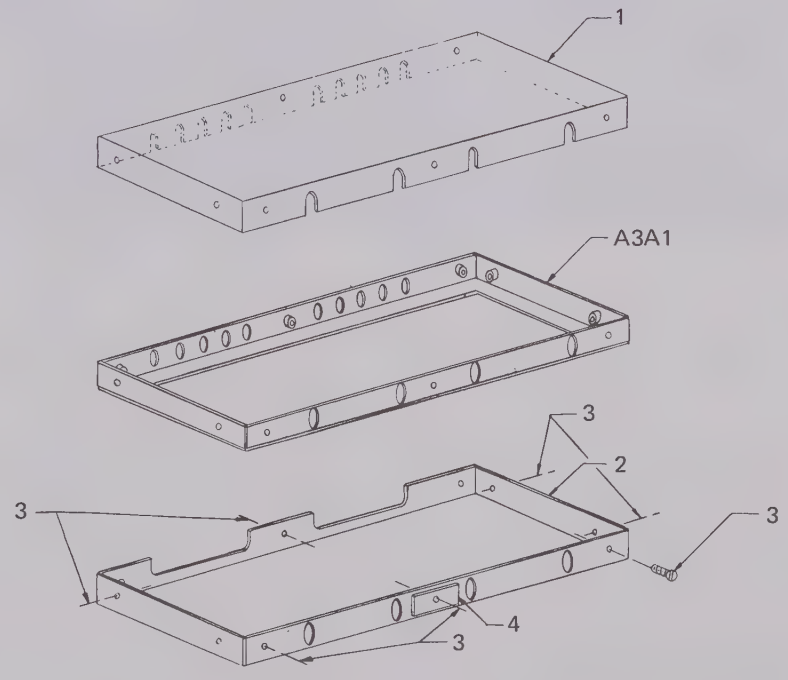


Figure 5-6 10 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY

## 10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A3A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A3A1 | **10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY**<br>**Figure 5-7 6160A-4009** | | | | REF | | |
| C1,C2, C6 thru C12, C25, C26, C36 thru C39, C43 | Cap, cer, 0.05 uf +80/-20%, 25V | 148924 | 72982 | 5855-Y5U 5032 | 16 | | |
| C3, C4, C5, C28, C29, C41, C42 | Cap, ta, 2.2 uf ±20%, 20V | 161927 | 56289 | 196D225X 0020 | 6 | | |
| C13, C15, C16, C32, C33, C35 | Cap, cer, 0.005 uf ±20%, 50V | 255471 | 32897 | 8121-050-651-005M | 6 | | |
| C44 thru C47 | Cap, feed-thru, 2500 pf, 500V | 248286 | 04222 | BSF1BB | 4 | | |
| C14 | Cap, cer, 7.5 pf ±0.25 pf, 500V | 329961 | 04222 | S1-1 | 1 | | |
| C17, C24, C31 | Cap, mica, 220 pf ±5%, 500V | 170423 | 53021 | D15F221J | 3 | | |
| C18, C20 | Cap, mica, 82 pf ±5%, 500V | 148502 | 53021 | D15E820J | 2 | | |
| C19 | Cap, mica, 33 pf ±5%, 500V | 160317 | 53021 | D15E330J | 1 | | |
| C21 | Cap, mica, 330 pf ±5%, 500V | 148445 | 53021 | D15F331J | 1 | | |
| C22 | Cap, var, cer, 4.5 to 50 pf +70/-20%, 250V | 321117 | 73899 | DVJ 305A | 1 | | |
| C23 | Cap, mica, 39 pf ±5%, 500V | 148544 | 53021 | D15E390J | 1 | | |

## 10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A3A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| C27, C40 | Cap, cer, 0.0012 uf ±10%, 500V | 106732 | 71590 | CF-122 | 2 | | |
| C30 | Cap, mica, 18 pf ±5%, 500V | 266585 | 53021 | D15C180J | 1 | | |
| C34 | Cap, var, 1 to 10 pf ±20%, 250V | 229930 | 73899 | VAM010W | 1 | | |
| CR1, CR6, CR7, CR13, CR14, CR20 | Diode, hot carrier | 313247 | 28480 | 5082-2811 | 6 | 2 | |
| CR2 thru CR5, CR9 thru CR12 | Diode, hot carrier | 329623 | 28480 | 2833 | 8 | 2 | |
| CR8, CR15 thru CR19, CR21 | Diode, silicon, 150 mA | 203323 | 03508 | 1N4148 | 7 | 2 | |
| J1 thru J4 | Conn, male, coaxial | 207639 | 13511 | 27 - 875 | 4 | | |
| L1 thru L6, L10 thru L15 | Bead, 6 turn | 320911 | 89536 | 320911 | 12 | | |
| L7 | Inductor, 0.15 uh ±10%, 2600 mA | 256297 | 24759 | MR-0.15 | 1 | | |
| L8,L9 | Inductor, 3.9 uh ±10%, 815 mA | 328054 | 24759 | MR-3.9 | 2 | | |
| Q1 thru Q4, Q17,Q18 | Tstr, silicon, PNP | 226290 | 04713 | MPS3640 | 6 | 2 | |

## 10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A3A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| Q5, Q6, Q15, Q16 | Tstr, silicon, NPN | 248351 | 04713 | MPS918 | 4 | 1 | |
| Q7 | Tstr, silicon, PNP | 195974 | 04713 | 2N3906 | 1 | 1 | |
| Q8,Q9 | Tstr, silicon, NPN | 168716 | 07263 | S19234 | 2 | 1 | |
| Q10, Q11, Q14 | Tstr, silicon, NPN | 218396 | 04713 | 2N3904 | 3 | 1 | |
| Q12, Q13 | Tstr, silicon, PNP | 225599 | 07263 | S22650 | 2 | 1 | |
| Q19 | Tstr, J-FET, N-Channel | 261578 | 89144 | U2366E | 1 | 1 | |
| R1 | Res, comp, 390Ω ±5%, ¼W | 147975 | 01121 | CB3915 | 1 | | |
| R2,R3 R9, R55 | Res, comp, 120Ω ±5%, ¼W | 170712 | 01121 | CB1215 | 4 | | |
| R4, R5, R15 | Res, comp, 3.3k ±5%, ¼W | 148056 | 01121 | CB3325 | 3 | | |
| R6, R7, R17, R34, R44, R45 | Res, comp, 220Ω ±5%, ¼W | 147959 | 01121 | CB2215 | 6 | | |
| R8, R11, R35, R41 | Res, comp 82Ω ±5%, ¼W | 149484 | 01121 | CB 8205 | 4 | | |
| R10, R39, R40, R53 | Res, comp, 47Ω ±5%, ¼W | 147892 | 01121 | CB4705 | 4 | | |
| R12, R14, R37, R42, R47, R51 | Res, comp, 1k ±5%, ¼W | 148023 | 01121 | CB1025 | 6 | | |
| R13, R54 | Res, comp, 470Ω ±5%, ¼W | 147983 | 01121 | CB4715 | 2 | | |

## 10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A3A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R16 | Res, comp, 15k ±5%, ¼W | 148114 | 01121 | CB1535 | 1 | | |
| R18, R22 | Res, comp, 2.2k ±5%, ¼W | 148049 | 01121 | CB2225 | 2 | | |
| R19, R20, R36 | Res, comp, 12k ±5%, ¼W | 159731 | 01121 | CB1235 | 3 | | |
| R21 | Res, comp, 1.8k ±5%, ¼W | 175042 | 01121 | CB1825 | 1 | | |
| R23, R32 | Res, comp, 6.8k ±5%, ¼W | 148098 | 01121 | CB6825 | 2 | | |
| R24 | Res, comp, 330k ±5%, ¼W | 192948 | 01121 | CB3315 | 1 | | |
| R25, R30, R49 | Res, comp, 8.2k ±5%, ¼W | 160796 | 01121 | CB8225 | 3 | | |
| R26, R33 | Res, comp, 4.7k ±5%, ¼W | 148072 | 01121 | CB4725 | 2 | | |
| R27, R31 | Res, met flm, 118k ±1%, 1/8W | 291310 | 91637 | MFF1-81183F | 2 | | |
| R28 | Res, met flm, 267k ±1%, 1/8W | 289090 | 91637 | MFF1-82673F | 1 | | |
| R29 | Res, var, cermet, 20k ±10%, ½W | 291609 | 71450 | 360S-203A | 1 | | |
| R38 | Res, comp, 3.9k ±5%, ¼W | 148064 | 01121 | CB3925 | 1 | | |
| R43 | Res, comp, 56Ω ±5%, ¼W | 147900 | 01121 | CB5605 | 1 | | |
| R46 | Res, comp, 18k ±5%, ¼W | 148122 | 01121 | CB1835 | 1 | | |
| R48, R56 | Res, comp, 120k ±5%, ¼W | 193458 | 01121 | CB1245 | 2 | | |
| R50 | Res, comp, 160Ω ±5%, ¼W | 261859 | 01121 | CB1615 | 1 | | |
| R52 | Res, comp, 68k ±5%, ¼W | 148171 | 01121 | CB6835 | 1 | | |
| T1 thru T5 | Transformer, 8 turn | 321067 | 89536 | 321067 | 5 | | |
| U1 | Mixer, double balanced | 320887 | 27956 | M6K | 1 | | |
| U2 | IC, operational amplifier | 329912 | 27014 | LM318H | 1 | 1 | |
| U3, U4, U5 | IC, operational amplifier | 271502 | 12040 | LM301A | 3 | 1 | |

## 10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A3A1

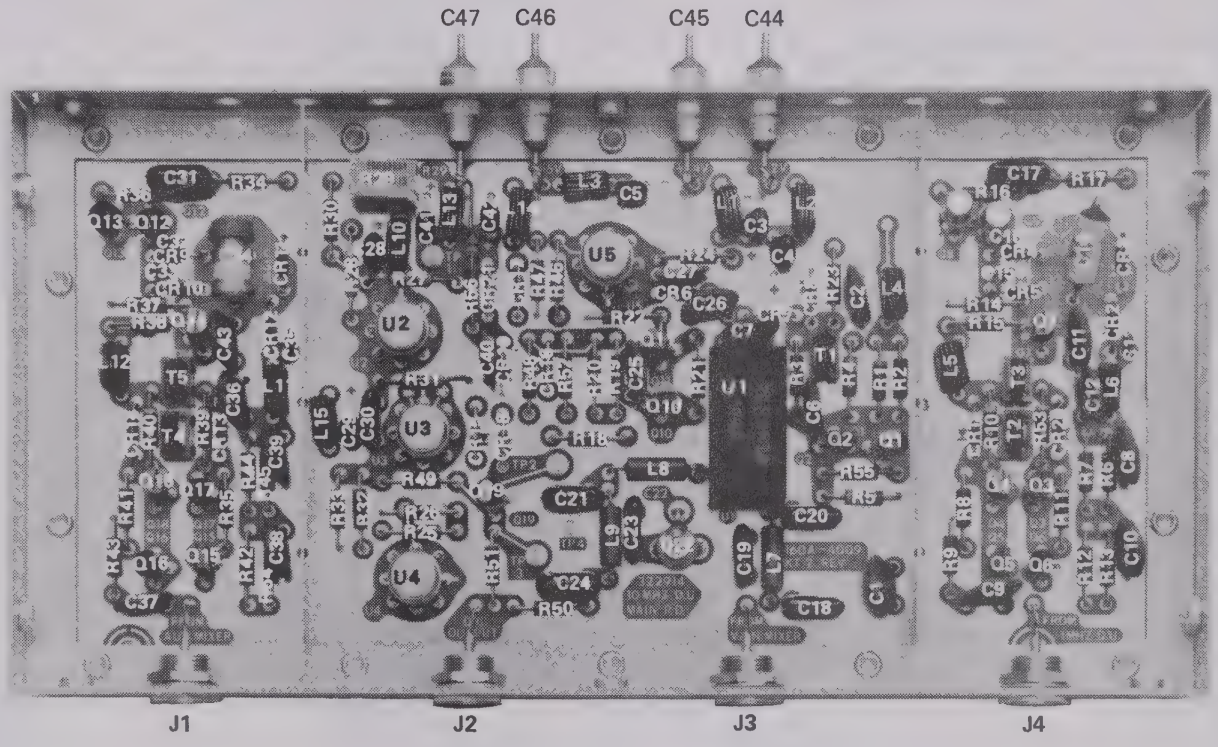


Figure 5-7. 10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A3A1

## 10 MHz I. F. MIXER MODULE ASSEMBLY, A4

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A4 | **10 MHz I. F. MIXER MODULE ASSEMBLY** **Figure 5-8 6160A-4108** | 323725 | 89536 | 323725 | REF | | |
| A4A1 | 10 MHz I. F. Mixer PCB Assembly | | | | 1 | | |
| 1 | Module cover, inner | 323204 | 89536 | 323204 | 1 | | |
| 2 | Module cover, outer | 323212 | 89536 | 323212 | 1 | | |
| 3 | Screw, 4 - 40 x ¼ PNH - Phillips | 129890 | 73734 | 19022 | 7 | | |
| 4 | Nameplate | 329227 | 89536 | 329227 | 1 | | |

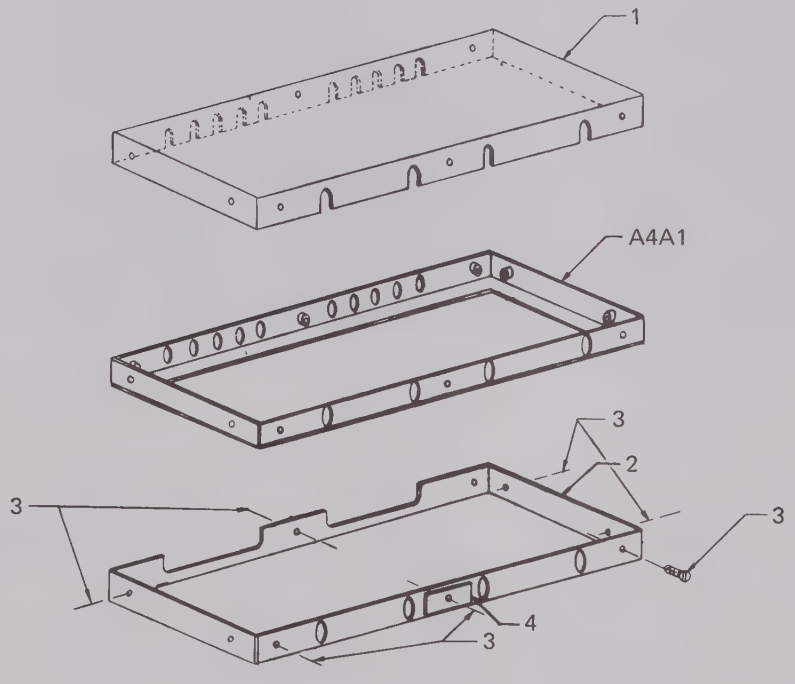


Figure 5-8. 10 MHz I.F. MIXER MODULE ASSEMBLY

## 10 MHz IF MIXER PCB ASSEMBLY, A4A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A4A1 | 10 MHz I.F. MIXER PCB ASSEMBLY<br>Figure 5-9 6160A-4008 | | | | REF | | |
| C1, C11, C34, C36, C39, C41, C43 | Cap, cer, 0.05 uf +80/-20%, 25V | 148924 | 72982 | 5855-Y5U-5032 | 7 | | |
| C2, C12, C23, C24, C25, C29, C33 | Cap, Ta, 2.2 uf ±20%, 20V | 161927 | 56289 | 196D225X0020 | 7 | | |
| C3 | Cap, cer, 0.005 uf ±20%, 50V | 225471 | 32897 | 8121-050-651-005M | 1 | | |
| C4,C5 C13, C14, C15, C30, C31, C32, C35, C37, C40, C42 | Cap, cer, 0.0012 uf ±10%, 500V | 106732 | 71590 | CF-122 | 12 | | |
| C6,C38 | Cap, mica, 22 pf ± 5%, 500V | 148551 | 53021 | D15220J | 2 | | |
| C7 | Cap, mica, 5.6 pf ±5%, 500V | 329631 | 53021 | D15C5-6J | 1 | | |
| C8, C26 | Cap, mica, 27 pf ±5%, 500V | 177998 | 53021 | D15E270J | 2 | | |
| C9,C16 | Cap, mica, 18 pf ±5%, 500V | 266585 | 53021 | D15C180J | 2 | | |
| C10 | Cap, mica, 15 pf ±5%, 500V | 148569 | 53021 | D15C150J | 1 | | |
| C17 | Cap, mica, 12 pf ±5%, 500V | 175224 | 53021 | D15E120J | 1 | | |
| C18 | Cap, mica, 100 pf ±5%, 500V | 148494 | 53021 | D15F101J | 1 | | |
| C19 | Cap, mica, 7.7 pf ±5%, 500V | 329649 | 53021 | D15C7-7J | 1 | | |

## 10 MHz IF MIXER PCB ASSEMBLY, A4A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| C20 | Cap, mica, 150 pf ±5%, 500V | 148478 | 53021 | D15F151J | 1 | | |
| C21 | Cap, mica, 33 pf, ±5%, 500V | 160317 | 53021 | D15E330J | 1 | | |
| C27 | Cap, mica, 130 pf ±5%, 500V | 266205 | 53021 | D15F131J | 1 | | |
| C28 | Cap, mica 91 pf ±5%, 500V | 277228 | 53021 | D15E910J | 1 | | |
| C44 thru C46 | Cap, feed-thru, 2500 pf, 500V | 248286 | 04222 | BSF-1BB | 3 | | |
| CR1,CR2 | Diode, hot carrier | 313247 | 28480 | 5083-2811 | 2 | 1 | |
| CR3 | Diode, silicon, 150 mA | 203323 | 03508 | 1N4148 | 1 | 1 | |
| J1 thru J4 | Connector, male, coaxial | 207639 | 13511 | 27-875 | 4 | | |
| L1 | Coil, 3-1/2, turn | 332783 | 89536 | 332783 | 1 | | |
| L2 | Coil, 1-1/2 turn | 332775 | 89536 | 332775 | 1 | | |
| L3, L4, L10 thru L13, L17, L18, L19 | Bead, 6 turn | 320911 | 89536 | 320911 | 9 | | |
| L5,L9 | Coil, 8 turn | 332809 | 89536 | 332809 | 2 | | |
| L6 | Coil, 1 turn | 332767 | 89536 | 332767 | 1 | | |
| L7 | Coil, 10 turn | 332817 | 89536 | 332817 | 1 | | |
| L8 | Coil, 5 turn | 332791 | 89536 | 332791 | 1 | | |
| L14 | Inductor, 0.47 uh ±5% | 329664 | 89536 | 329664 | 1 | | |
| L15, L16 | Inductor, 0.39 uh | 329656 | 89536 | 329656 | 2 | | |
| Q1, Q2, Q3 | Tstr, silicon NPN | 260638 | 25403 | A485 | 3 | 1 | |

## 10 MHz IF MIXER PCB ASSEMBLY, A4A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| Q4 | Tstr, silicon NPN | 248351 | 04713 | MPS918 | 1 | 1 | |
| Q5,Q7, Q10 | Tstr, silicon NPN | 226290 | 04713 | MPS3640 | 3 | 1 | |
| Q6 | Tstr, FET, N-Channel | 288324 | 15818 | U1994E | 1 | 1 | |
| Q8, Q9 | Tstr, silicon NPN | 195974 | 04713 | 2N 3906 | 2 | 1 | |
| R1 | Res, comp, 150Ω ±5%, ¼W | 147934 | 01121 | CB1515 | 1 | | |
| R2, R3 | Res, comp, 430Ω ±5%, ¼W | 203869 | 01121 | CB4315 | 2 | | |
| R4, R22, R40 R41 | Res, comp, 100Ω ±5%, ¼W | 147926 | 01121 | CB1015 | 4 | | |
| R5, R6 | Res, comp, 47Ω ±10%, 1/8W | 272211 | 01121 | BB4701 | 2 | | |
| R7 | Res, comp, 68Ω ±5%, ¼W | 147918 | 01121 | CB6805 | 1 | | |
| R8 | Res, comp, 470Ω ±5%, ¼W | 147983 | 01121 | CB4715 | 1 | | |
| R9 | Res, comp, 560Ω ±5%, ¼W | 147991 | 01121 | CB5615 | 1 | | |
| R10 | Res, comp, 270Ω ±5%, ¼W | 160804 | 01121 | CB2715 | 1 | | |
| R11 | Res, comp 130Ω ±5%, ¼W | 325704 | 01121 | CB1315 | 1 | | |
| R12 | Res, comp, 75Ω ±5% ¼W | 246736 | 01121 | CB7505 | 1 | | |
| R13 | Res, comp, 100Ω ±10%, 1/8W | 261826 | 01121 | BB1011 | 1 | | |
| R14, R16 | Res, comp, 240Ω ±5%, ¼W | 221895 | 01121 | CB2415 | 2 | | |
| R15 | Res, comp, 43Ω ±5%, ¼W | 177162 | 01121 | CB4305 | 1 | | |
| R17, R25 | Res, comp 82Ω ±5%, ¼W | 149484 | 01121 | CB8205 | 2 | | |
| R18, R37, R38 | Res, comp, 2k ±5%, ¼W | 202879 | 01121 | CB2025 | 3 | | |
| R19, R24 | Res, comp, 39Ω ±5%, ¼W | 193391 | 01121 | CB3905 | 2 | | |
| R20 | Res, comp, 22k ±5%, ¼W | 148130 | 01121 | CB2235 | 1 | | |
| R21, R39 | Res, comp, 220Ω ±5%, ¼W | 147959 | 01121 | CB2215 | 2 | | |
| R23, R27 | Res, comp, 510Ω ±5%, ¼W | 218032 | 01121 | CB5115 | 2 | | |

## 10 MHz IF MIXER PCB ASSEMBLY, A4A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R26, R42 | Res, comp, 390Ω ±5%, ¼W | 147975 | 01121 | CB3915 | 2 | | |
| R28 | Res, comp, 1.2k ±5%, ¼W | 190371 | 01121 | CB1225 | 1 | | |
| R29 | Res, comp, 6.8k ±5%, ¼W | 148098 | 01121 | CB6825 | 1 | | |
| R30 | Res, comp, 47k ±5%, ¼W | 148163 | 01121 | CB4735 | 1 | | |
| R31, R32 | Res, comp, 750Ω ±5%, ¼W | 218024 | 01121 | CB7515 | 2 | | |
| R33, R34 | Res, comp, 12k ±5%, ¼W | 159731 | 01121 | CB1235 | 2 | | |
| R35 | Res, var, cermet, 1k ±20%, ¼W | 193060 | 80294 | 3329H-1-102 | 1 | | |
| R36 | Res, comp, 910Ω ±5%, ¼W | 203851 | 01121 | CB9115 | 1 | | |
| R43 | Res, comp, 330Ω ±5%, ¼W | 147967 | 01121 | CB3315 | 1 | | |
| T1,T2 | Transformer | 320903 | 89536 | 320903 | 2 | | |
| T3, T4 | Transformer, 8 turn | 321067 | 89536 | 321067 | 2 | | |
| U1 | Mixer, double balance | 248260 | 27956 | M6F | 1 | 1 | |

# 10 MHz IF MIXER PCB ASSEMBLY, A4A1

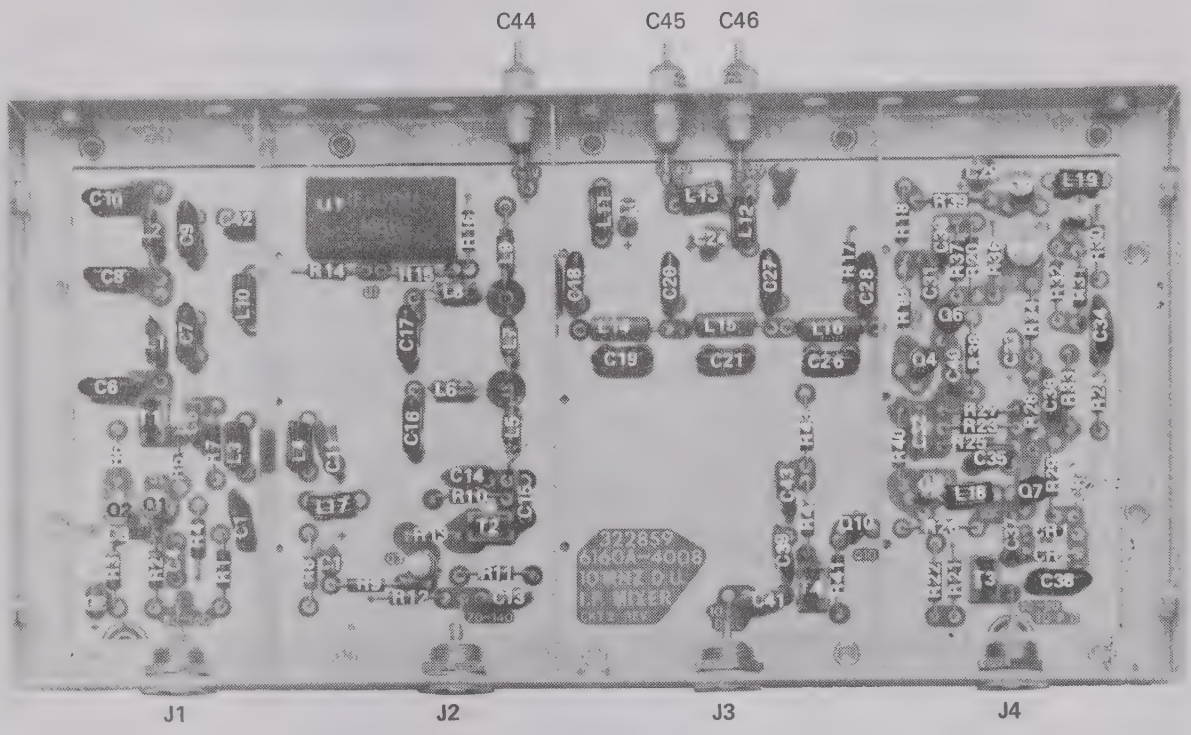


Figure 5-9. 10 MHz IF MIXER PCB ASSEMBLY, A4A1

## 10 MHz STEP LOOP VCO MODULE ASSEMBLY, A5

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A5 | **10 MHz STEP LOOP VCO MODULE ASSEMBLY**<br>**Figure 5-10 . 6160A-4107-1** | 341545 | 89536 | 341545 | REF | | |
| A5A1 | 10 MHz Step Loop VCO PCB Assembly | | | | 1 | | |
| 1 | Module Cover - inner | 323204 | 89536 | 323204 | 1 | | |
| 2 | Module cover - outer | 323212 | 89536 | 323212 | 1 | | |
| 3 | Screw, PNH - Phillips 4 - 40 X ¼ | 129890 | 73734 | 19022 | 7 | | |
| 4 | Nameplate | 329219 | 89536 | 329219 | 1 | | |

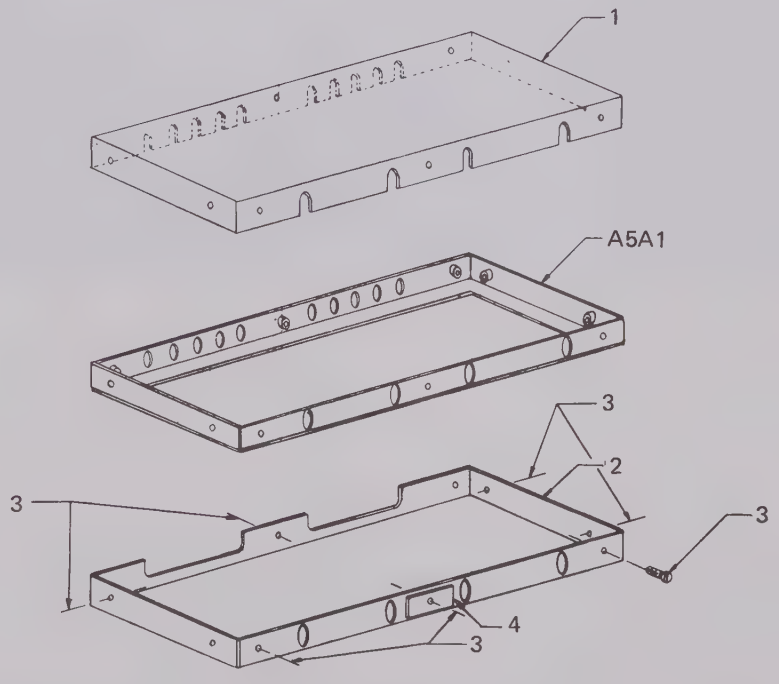


Figure 5-10. 10 MHz STEP LOOP VCO MODULE ASSEMBLY, A5

## 10 MHz STEP LOOP VCO PCB ASSEMBLY, A5A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A5A1 | **10 MHz STEP LOOP VCO PCB ASSEMBLY**<br>**Figure 5-11 6160A-4007** | | | | REF | | |
| C1 | Cap, mica, 24.5 pf ±2%, 500V | 335620 | 53021 | D15C24.5G | 1 | | |
| C2 | Cap, mica, 15 pf ±2%, 500V | 335612 | 53021 | D15C150G | 1 | | |
| C3 | Cap, mica, 10 pf ±2%, 500V | 335638 | 53021 | D15C100G | 1 | | |
| C4 | Cap, mica, 13.5 pf ±2%, 500V | 335646 | 53021 | D15C13.5G | 1 | | |
| C5 thru C9, C11, C14, C17, C26 | Cap, Ta, 2.2 uf ±20%, 20V | 161927 | 56289 | 196D225X0020 | 9 | | |
| C10, C13, C15 | Cap, cer, 0.05 uf +80/-20%, 25V | 148924 | 72982 | 5855-Y5U-5032 | 3 | | |
| C12, C16 | Cap, cer, 0.0012 uf ±10%, 500V | 106732 | 71590 | CF-122 | 2 | | |
| C18, C22, C23 | Cap, mica, 33 pf ±5%. 500V | 160317 | 53021 | D15E330J | 3 | | |
| C19 | Cap, mica, 430 pf ±5%, 500V | 177980 | 53021 | D15F431J | 1 | | |
| C20 | Cap, mica, 39 pf ±5%, 500V | 148544 | 53021 | D15E390J | 1 | | |
| C21 | Cap, var, cer, 4.5 to 50 pf +70/-20%, 250V | 321117 | 73899 | DVJ305A | 1 | | |
| C24 | Cap, mica, 330 pf ±5%, 500V | 148445 | 53021 | D15F331J | 1 | | |
| C25 | Cap, plstc, 0.033 uf ±10%, 50V | 271841 | 06001 | 75F1R5A334 | 1 | | |
| C27 thru C32 | Cap, feed-thru, 2500 pf, 500V | 248286 | 04222 | BSF-1BB | 6 | | |
| CR1, CR4 | Diode, hot carrier, 1.0 pf, 32V | 333906 | 28480 | 5082-2835 | 2 | 1 | |
| CR2, CR3 | Diode, pin, switching | 334227 | 04713 | MPN 3402 | 2 | 1 | |
| CR5 thru CR8 | Diode, tuning, hyper-abrupt | 320200 | KEV Elec-tronics | TYPE-KV2001 | 4 | 1 | |

## 10 MHz STEP LOOP VCO PCB ASSEMBLY, A5A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| CR9 thru CR19 | Diode, silicon, 150 mA | 203323 | 03408 | 1N4148 | 11 | 1 | |
| J1 thru J4 | Connector, male, coaxial | 207639 | 13511 | 27-875 | 4 | | |
| L1 | Coil, 1 turn | 332767 | 89536 | 332767 | 1 | | |
| L2 | Coil, 5 turn | 332791 | 89536 | 332791 | 1 | | |
| L3 | Coil, 10 turn | 332817 | 89536 | 332817 | 1 | | |
| L4, L5 | Coil, 8 turn | 332809 | 89536 | 332809 | 2 | | |
| L6 thru L11 | Bead, 6 turn | 320911 | 89536 | 320911 | 6 | | |
| L14 | Bead, 1 turn | 219535 | 02114 | 56-060-85-3B | 1 | | |
| L15 | Inductor, 3.9 uh | 328054 | 24759 | MR-3.9 | 1 | | |
| L16 | Inductor, 1 uh | 320952 | 24759 | MR-1.0 | 1 | | |
| Q1, Q16, Q18 | Tstr, silicon, NPN | 218396 | 03713 | 2N 3904 | 3 | 1 | |
| Q2, Q17, Q19, Q20, Q24 | Tstr, silicon, PNP | 195974 | 04713 | 2N 3906 | 5 | 1 | |
| Q3 thru Q10, Q15 | Tstr, silicon, NPN | 242065 | 04713 | 2N 5089 | 9 | 2 | |
| Q11 thru Q14 | Tstr, silicon, NPN | 248351 | 04713 | MPS 918 | 4 | 1 | |
| Q21, Q23 | Tstr, silicon, PNP, dual | 242016 | 11726 | QD401-78E | 2 | 1 | |
| Q22 | Tstr, silicon, NPN, dual | 295717 | 11726 | QD101-78E | 1 | 1 | |

## 10 MHz STEP LOOP VCO PCB ASSEMBLY, A5A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R1, R4, R5 | Res, comp, 4.7k ±5%, ¼W | 148072 | 01121 | CB 4725 | 3 | | |
| R2, R3 | Res, comp, 390Ω ±5%, ¼W | 147975 | 01121 | CB 3915 | 2 | | |
| R6, R43 | Res, comp, 12k ±5%, ¼W | 159731 | 01121 | CB1235 | 2 | | |
| R7 | Res, comp, 10k ±5%, ¼W | 148106 | 01121 | CB 1035 | 1 | | |
| R8 | Res, met flm, 28.7k ±1%, 1/8W | 235176 | 91637 | MFF1-82872F | 1 | | |
| R9 | Res, met flm, 15.8k ±1%, 1/8W | 335398 | 91637 | MFF1-81582F | 1 | | |
| R10 | Res, met flm, 16.5k ±1%, 1/8W | 335380 | 91637 | MFF1-81652F | 1 | | |
| R11 | Res, met flm, 17.4k ±1%, 1/8W | 335372 | 91637 | MFF1-81742F | 1 | | |
| R12 | Res, met flm, 22.1k ±1%, 1/8W | 335364 | 91637 | MFF1-82212F | 1 | | |
| R13 | Res, met flm, 28.7k ±1%, 1/8W | 335315 | 91637 | MFF1-82872F | 1 | | |
| R14 | Res, met flm, 38.3k ±1%, 1/8W | 235323 | 91637 | MFF1-83832F | 1 | | |
| R15 | Res, met flm, 71.5k ±1%, 1/8W | 291435 | 91637 | MFF1-87152F | 1 | | |
| R16, R35, R40, R41, R46 | Res, comp, 2.2k ±5%, ¼W | 148049 | 91637 | CB 2225 | 5 | | |
| R17 | Res, comp, 2.7k ±5%, ¼W | 170720 | 01121 | CB 2725 | 1 | | |
| R18, R19, R24, R25 | Res, comp, 47Ω ±10%, 1/8W | 272211 | 01121 | BB 4701 | 4 | | |
| R20, R56, R57 | Res, comp, 100 Ω ±5%, ¼W | 147926 | 01121 | CB1015 | 3 | | |
| R21 | Res, comp, 270Ω ±5%, ¼W | 160804 | 01121 | CB2715 | 1 | | |
| R22, R26, R27 | Res, comp, 220Ω ±5%, ¼W | 147959 | 01121 | CB 2015 | 3 | | |
| R23 | Res, comp, 68Ω ±5%, ¼W | 147918 | 01121 | CB6805 | 1 | | |
| R28, R29 | Res, comp, 470Ω ±5%, ¼W | 147983 | 01121 | CB 4715 | 2 | | |

## 10 MHz STEP LOOP VCO PCB ASSEMBLY, A5A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R30 | Res, comp, 10Ω ±10%, 1/8 W | 321125 | 01121 | BB1001 | 1 | | |
| R31 | Res, met flm. 9.09k ±1%, 1/8W | 335406 | 91637 | MFF1-89091F | 1 | | |
| R32 | Res, met flm, 115k ±1%, 1/8W | 335356 | 91637 | MFF1-81153F | 1 | | |
| R33 | Res, met flm, 12.7k ±1%, 1/8W | 335349 | 91637 | MFF1-81272F | 1 | | |
| R34 | Res, met flm, 13.3k ±1%, 1/8W | 296566 | 91637 | MFF1-81332F | 1 | | |
| R36 | Res, met flm, 1.07k ±1%, 1/8W | 335448 | 91637 | MFF1-81071F | 1 | | |
| R37 | Res, met flm, 11.3k ±1%, 1/8W | 335414 | 91637 | MFF1-81132F | 1 | | |
| R38 | Res, met flm, 1.54k ±1%, 1/8W | 335331 | 91637 | MFF1-81541F | 1 | | |
| R39, R45 | Res, comp, 15k ±5%, ¼W | 148114 | 01121 | CB1525 | 1 | | |
| R42 | Res, var, cermet, 500Ω ±20%, ½W | 226068 | 80294 | 3329H-1-501 | 1 | | |
| R44 | Res, comp, 6.8k ±5%, ¼W | 148098 | 01121 | CB6825 | 1 | | |
| R47, R48 | Res, met flm, 2k ±1%, 1/8W | 335422 | 91637 | MFF1-82001F | 2 | | |
| R49 | Res, met flm, 26.1k ±1%, 1/8W | 335430 | 91637 | MFF1082612F | 1 | | |
| R50 | Res, met flm, 11.3k ±1%, 1/8W | 293639 | 91637 | MFF1-81132F | 1 | | |
| R51, R52 | Res, met flm, 1.21k ±1%, 1/8W | 229146 | 91637 | MFF1-81211F | 2 | | |
| R53 | Res, met flm, 34.8k ±1%, 1/8W | 261487 | 91637 | MFF1-83482F | 1 | | |
| R54 | Res, met flm, 121k ±1%, 1/8W | 229369 | 91637 | MFF1-81213F | 1 | | |
| R55 | Res, met flm. 22.1k ±1%, 1/8W | 235234 | 91637 | MFF1-82212F | 1 | | |
| R58 | Res, comp, 15Ω ±10%, 1/8W | 261800 | 01121 | BB 1501 | 1 | | |
| R59 | Res, met flm, 16.2k ±1%, 1/8W | 226233 | 91637 | MFF1-81622F | 1 | | |
| R60 | Res, var, cermet, 2k ±20%, ½W | 226076 | 19701 | ET50W202 | 1 | | |
| R70 | Res, var, cermet, 1k ±20%, ¼W | 193060 | 80294 | 3329H - 1-102 | 1 | | |
| R80 | Res, var, cermet, 50k ±10%, ½W | 335778 | 71450 | 360T-502A | 1 | | |
| R90 | Res, var, cermet, 20k ±10%, 1/8W | 335760 | 71450 | 360T-202A | 1 | | |
| R100, R110, R120 | Res, var, cermet, 10k ±10%, ½W | 309674 | 71450 | 360T -102A | 3 | | |

## 10 MHz STEP LOOP VCO PCB ASSEMBLY, A5A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R130, R140 | Res, var, cermet, 5k ±10%, ½W | 327569 | 71450 | 360T-502A | 2 | | |
| T1, T2, T3 | Transformer | 320903 | 89536 | 320903 | 3 | | |
| U1, U3 | IC, Operational amplifier | 340067 | 07263 | U5B7101392 | 1 | 1 | |
| U2 | IC, Operational amplifier | 271502 | 12040 | LM301A | 2 | 1 | |
| U4 | IC, TTL, BCD to decimal decoders | 293142 | 01295 | SN7442N | 1 | 1 | |

## 10 MHz STEP LOOP VCO PCB ASSEMBLY, A5A1

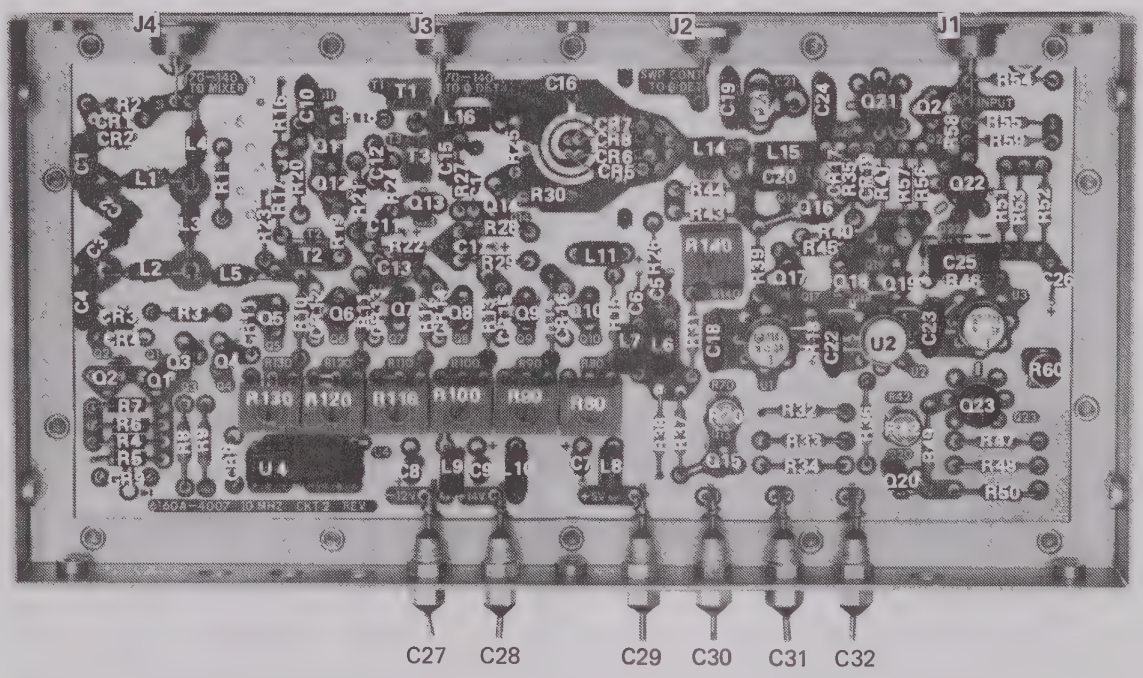


Figure 5-11. 10 MHz STEP LOOP VCO PCB ASSEMBLY, A5A1

## 10 MHz STEP LOOP PHASE DETECTOR MODULE ASSEMBLY, A6

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A6 | **10 MHz STEP LOOP PHASE DETECTOR MODULE ASSEMBLY** **Figure 5-12 6160A-4106-1** | 341537 | 89536 | 341537 | REF | | |
| A6A1 | 10 MHz Step Loop Phase Detector PCB Assembly 6160A-4006 | | | | 1 | | |
| 1 | Module Cover - inner | 323204 | 89536 | 323204 | 1 | | |
| 2 | Module Cover - outer | 323212 | 89536 | 323212 | 1 | | |
| 3 | Screw, PNH - Phillips. 4-40 X ¼ | 129890 | 73734 | 19022 | 7 | | |
| 4 | Nameplate | 329201 | 89536 | 329201 | 1 | | |

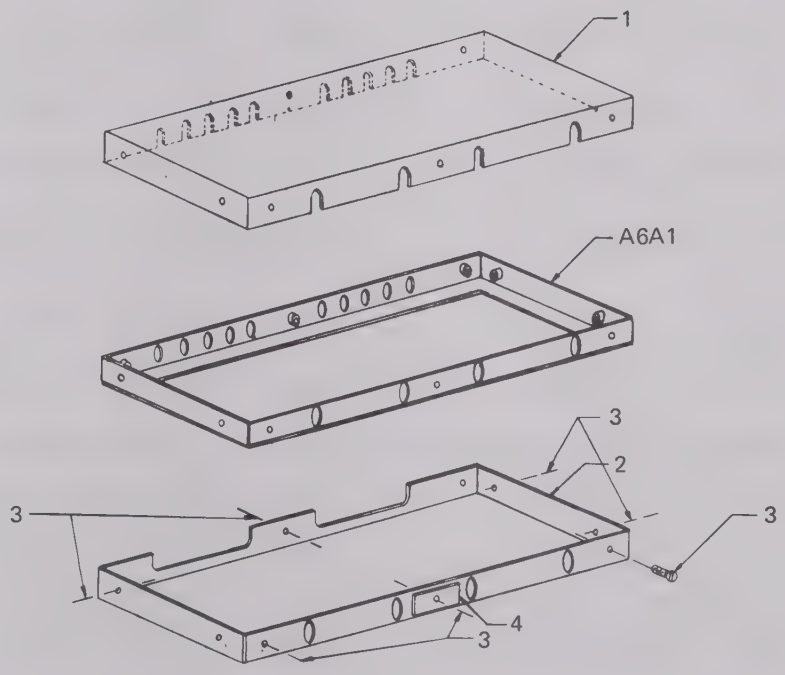


Figure 5-12. 10 MHz STEP LOOP PHASE DETECTOR MODULE ASSEMBLY, A6

## 10 MHz STEP LOOP PHASE DETECTOR PCB ASSEMBLY, A6A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A6A1 | **10 MHZ STEP LOOP PHASE DETECTOR PCB ASSEMBLY** **Figure 5-13 6160A-4006** | | | | REF | | |
| C1,C5, C6, C18, C19, C24, C26, C27, C28 | Cap, cer, 0.05 uf +80/-20%, 25V | 148924 | 72984 | 5855-YSU-5032 | 9 | | |
| C2, C23, C40, C41, C42 | Cap, Ta, 2.2 uf ±20%, 20V | 161927 | 56289 | 196D225X0020 | 5 | | |
| C3, C12, C29, C35 | Cap, cer, 0.0012 uf ±10%, 500V | 106732 | 71590 | CF-122 | 4 | | |
| C4 | Cap, cer, 0.005 uf ±20%, 500V | 255471 | 32897 | 8121-050-651-005M | 1 | | |
| C7 | Cap, mica, 22 pf ±5%, 500V | 148551 | 53021 | D15E220J | 1 | | |
| C8 | Cap, mica, 56 pf ±5%, 500V | 329631 | 53021 | D15C560F | 1 | | |
| C9, C31, C34 | Cap, mica, 27 pf ±5%, 500V | 177998 | 53021 | D15E270J | 3 | | |
| C10 | Cap, mica, 18 pf ±5%, 500V | 266585 | 53021 | D15C180J | 1 | | |
| C11, C22 | Cap, mica, 15 pf ±5%, 500V | 148569 | 53021 | D15C150J | 2 | | |
| C13 | Cap, var, cer, 4.5 to 50 pf+70/-20%,250V | 321117 | 73899 | DVJ 305A | 1 | | |
| C14 | Cap, mica, 39 pf ±5%, 500V | 148544 | 53021 | D15E 390J | 1 | | |
| C15 | Cap, mica, 330 pf ±5%, 500V | 148445 | 53021 | D15F 331J | 1 | | |
| C16 | Cap, mica, 220 pf ±5%, 500V | 170423 | 53021 | D15F 221J | 1 | | |
| C17 | Cap, cer, 0.01 uf +80/-20%, 25/50V | 335786 | 32897 | 5835-000-Y5U - 1032 | 1 | | |
| C20, C21, C25 | Cap, mica, 430 pf ±5%, 500V | 177980 | 53021 | D15F 431J | 3 | | |

## 10 MHz STEP LOOP PHASE DETECTOR PCB ASSEMBLY, A6A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| C30 | Cap, mica, 2 pf ±0.05 pf | 175208 | 53021 | D15C020D | 1 | | |
| C32 | Cap, Ta, 10 uf ±20%, 10V | 176214 | 56289 | 196D106X001 | 1 | | |
| C33 | Cap, mica, 51 pf ±2%, 500V | 335810 | 53021 | D15E510G | 1 | | |
| C36 | Cap, mica, 15 pf ±2%, 500V | 335612 | 53021 | D15C150G | 1 | | |
| C37 | Cap, mica, 24.5 pf ±2%, 500V | 335620 | 53021 | D15C24.5G | 1 | | |
| C38 | Cap, mica, 10 pf ±2%, 500V | 335638 | 53021 | D15C100G | 1 | | |
| C39 | Cap, mica, 13.5 pf ±2%, 500V | 335656 | 53021 | D15C13.5G | 1 | | |
| C41 thru C45 | Cap, feed-thru, 2500 pf, 500V | 248286 | 04222 | BSF-1BB | 4 | | |
| CR1, CR9, CR10, CR12 thru CR17, CR19, CR20 | Diode, silicon, 150 mA | 203323 | 03508 | 1N4148 | 11 | 1 | |
| CR2, CR3 | Diode, hot carrier, 1.2 pf, 0.41V | 313247 | 28480 | 5082-2811 | 2 | 1 | |
| CR4, CR6, CR18 | Diode, hot carrier, 1.0 pf, .32V | 333906 | 28480 | 5082-2835 | 3 | 1 | |
| CR5, CR7, CR8 | Diode, pin, silicon, switching | 334227 | 04713 | MPN3402 | 3 | 1 | |
| CR11 | Diode, step recovery | 335588 | 28480 | 5082-0180 | 1 | 1 | |
| J1 thru J4 | Connector, male, coaxial | 207639 | 13511 | 27-875 | 4 | | |
| L1 | Coil, assy, VHF, 1 turn | 332767 | 89536 | 332767 | 1 | | |
| L2 | Coil, assy, VHF, 5 turn | 332791 | 89536 | 332791 | 1 | | |
| L3,L4 L5, L13, L14, L15, L17, L18, L19 | Inductor, 6 turn beads | 320911 | 89536 | 320911 | 9 | | |

## 10 MHz STEP LOOP PHASE DETECTOR PCB ASSEMBLY, A6A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| L6 | Coil, assy, VHF, .3 1/2 turn | 332783 | 89536 | 332783 | 1 | | |
| L7 | Coil, assy, VHF, 1 1/2 turn | 332775 | 89536 | 332775 | 1 | | |
| L8, L10, L20 | Coil, assy, VHF, 8 turn | 332809 | 89536 | 332809 | 3 | | |
| L9, L11 | Coil, assy, VHF, 10 turn | 332817 | 89536 | 332817 | 2 | | |
| L12, L21 | Inductor, 3.9 uh ±10%, 815 mA | 328054 | 24759 | MR-3.9 | 2 | | |
| L16 | Inductor, 0.27 uh ±10%, 1625 mA | 313031 | 24759 | MR-0.27 | 1 | | |
| L22 | Inductor, 0.47 uh ±10%, 1060 mA | 320929 | 24759 | MR-0.47 | 1 | | |
| Q1, Q2 | Tstr, silicon, NPN | 260638 | 25403 | A485 | 2 | 1 | |
| Q3, Q6, Q7, Q15, Q16 | Tstr, silicon, NPN | 195974 | 04713 | 2N 3906 | 5 | 1 | |
| Q4, Q8, Q9, Q12, Q13, Q14 | Tstr, silicon, NPN | 218396 | 04713 | 2N3904 | 6 | 2 | |
| Q5 | Tstr, silicon, NPN | 242065 | 04713 | 2N5089 | 1 | 1 | |
| Q10, Q11 | Tstr, silicon, NPN | 179374 | 07269 | 2N2218 | 2 | 1 | |
| R1 | Res, comp, 150Ω ±5%, ¼W | 147934 | 01121 | CB1515 | 1 | | |
| R2,R3 | Res, comp, 430Ω ±5%, ¼W | 203869 | 01121 | CB4315 | 2 | | |
| R4, R35 | Res, comp, 100Ω ±5%, ¼W | 147926 | 01121 | CB1015 | 2 | | |
| R5,R7, R32, R33 | Res, comp, 47Ω ±10%, 1/8W | 272211 | 01121 | BB4701 | 4 | | |
| R6 | Res, comp, 68Ω ±5%, ¼W | 147918 | 01121 | CB6805 | 1 | | |

## 10 MHz STEP LOOP PHASE DETECTOR PCB ASSEMBLY, A6A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R6 | Res, comp, 68Ω ±5%, ¼W | 147918 | 01121 | CB6805 | 1 | | |
| R8, R13, R56 | Res, comp, 1k ±5%, ¼W | 148023 | 01121 | CB1025 | 3 | | |
| R9, R14, R18, R42, R52 | Res, comp, 6.8k ±5%. ¼W | 148098 | 01121 | CB6825 | 5 | | |
| R10, R12 | Res, comp, 220Ω ±5%, ¼W | 147959 | 01121 | CB2215 | 2 | | |
| R11 | Res, comp, 1.8k ±5%, ¼W | 175042 | 01121 | CB1825 | 1 | | |
| R15 | Res, comp, 5.6k ±5%, ¼W | 148080 | 01121 | CB5625 | 1 | | |
| R16, R24, R57 | Res, comp, 3.3k ±5%, ¼W | 148056 | 01121 | CB3325 | 3 | | |
| R17 | Res, comp, 15k ±5%, ¼W | 234682 | 01121 | CB1535 | 1 | | |
| R19 | Res, comp, 56k ±5%, ¼W | 170738 | 01121 | CB5635 | 1 | | |
| R20 | Res, met flm, 37.4k ±1%, 1/8W | 226241 | 91637 | MFF1-83742F | 1 | | |
| R21 | Res, met flm, 10k ±1%, 1/8W | 168260 | 91637 | MFF1-81002F | 1 | | |
| R22 | Res, met flm, 40.2k ±1%, 1/8W | 235333 | 91637 | MFF1-84022F | 1 | | |
| R23 | Res, met flm, 97.6k ±1%, 1/8W | 241380 | 91637 | MFF1-89762F | 1 | | |
| R25, R26 | Res, comp, 1.5k ±5%, ¼W | 148031 | 01121 | CB1525 | 2 | | |
| R27, R34 | Res, var, cermet, 200Ω ±20%, ½W | 226050 | 80294 | 3329H-1-201 | 2 | | |
| R28, R41 | Res, comp, 130Ω ±5%, ¼W | 325704 | 01121 | CB1315 | 2 | | |
| R29, R30 | Res, comp, 820Ω ±5%, ¼W | 148015 | 01121 | CB8215 | 2 | | |
| R31 | Res, comp, 91Ω ±5%, ¼W | 221887 | 01121 | CB9105 | 1 | | |
| R36 | Res, comp, 10Ω ±5%, ¼W | 147868 | 01121 | CB1005 | 1 | | |
| R37 | Res, comp 270Ω ±10%, 1/8W | 261834 | 01121 | BB2711 | 1 | | |
| R38 | Res, comp, 270Ω ±5%, ¼W | 160804 | 01121 | CB2715 | 1 | | |

## 10 MHz STEP LOOP PHASE DETECTOR PCB ASSEMBLY, A6A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R39 | Res, comp, 180Ω ±5%, ¼W | 147942 | 01121 | CB1815 | 1 | | |
| R40 | Res, comp, 43Ω ±5%, ¼W | 177162 | 01121 | CB4305 | 1 | | |
| R43, R50 R51 | Res, comp, 390Ω ±5%, ¼W | 147975 | 01121 | CB3915 | 1 | | |
| R44, R45 | Res, comp, 10k ±5%, ¼W | 148106 | 01121 | CB1005 | 2 | | |
| R46 | Res, comp, 2.2k ±5%, ¼W | 148049 | 01121 | CB2225 | 1 | | |
| R47, R48 | Res, comp, 4.7k ±5%, ¼W | 148072 | 01121 | CB4725 | 2 | | |
| R49 | Res, comp, 12k ±5%, ¼W | 159731 | 01121 | CB1235 | 1 | | |
| R53 | Res, comp, 51Ω ±5%, ¼W | 221879 | 01121 | CB5105 | 1 | | |
| R54 | REs, comp, 110Ω ±5%, ¼W | 193474 | 01121 | CB1115 | 1 | | |
| R55 | Res, comp, 15k ±5%, ¼W | 148114 | 01121 | CB1535 | 1 | | |
| R60 | Res, comp, 100Ω ± 10% , 1/8W | 261826 | 01121 | BB1011 | 1 | | |
| T1, T2, T3 | Transformer | 320903 | 89536 | 320903 | 3 | | |
| T4 | Transformer | 338905 | 89536 | 338903 | 1 | | |
| U1 | IC, TTL, Qua 2-Input Nand Gate | 292953 | 01295 | SN7400N | 1 | 1 | |
| U2 | IC, Operational amplifier | 271502 | 12040 | LM301A | 1 | 1 | |
| U3 | IC, mixer, double balance, ring modulator | 248260 | 27956 | M6F | 1 | 1 | |

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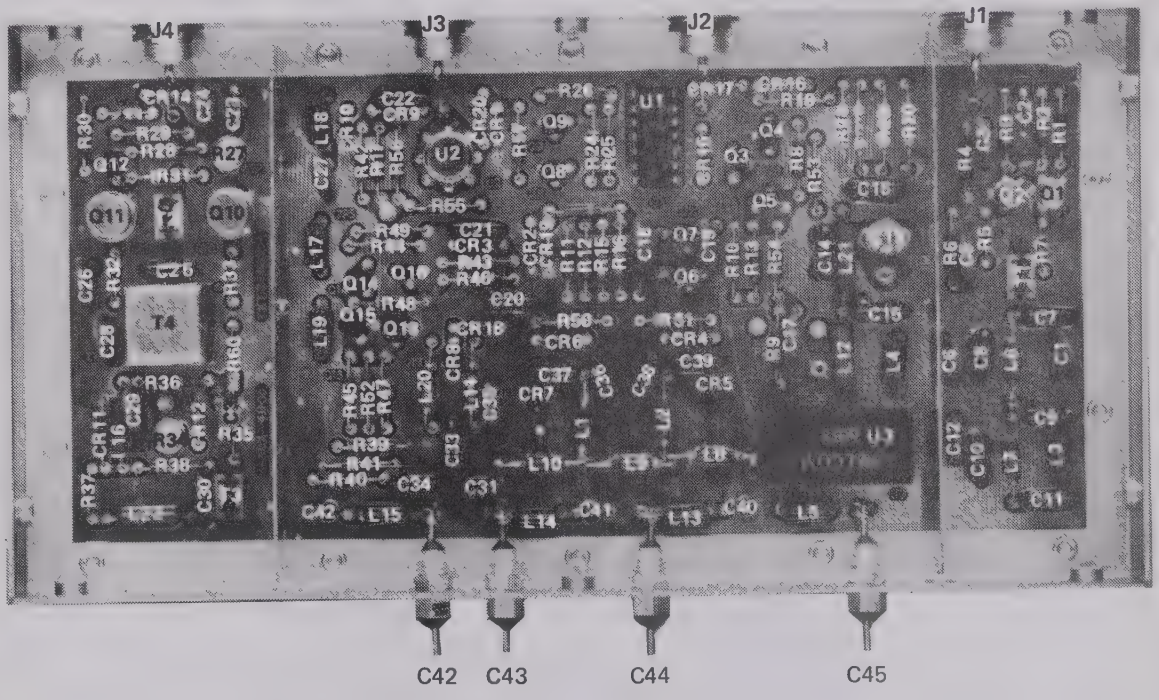
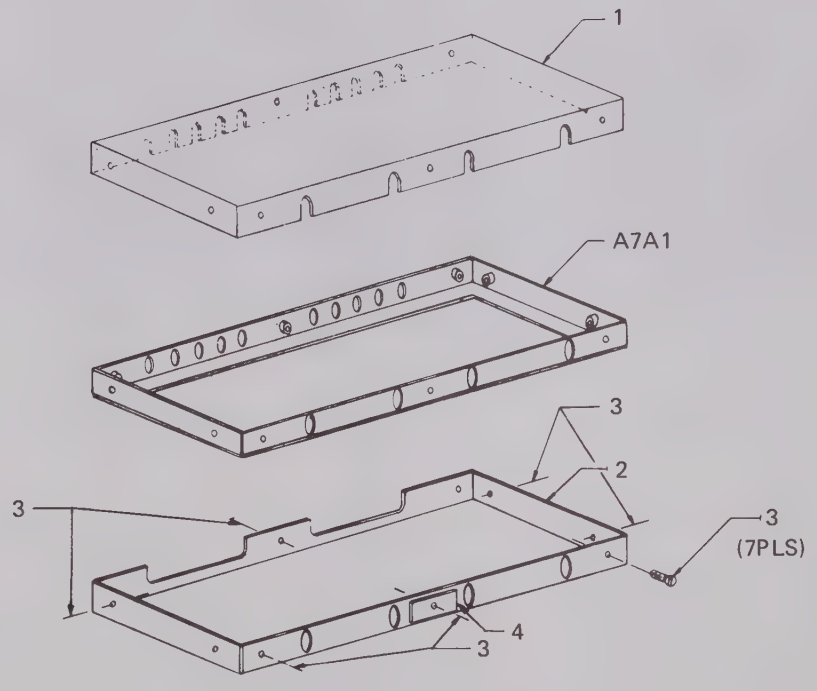



Figure 5-13. 10 MHz STEP LOOP PHASE DETECTOR PCB ASSEBMLY, A6A1

## INPUT FILTER MODULE ASSEMBLY, A7

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A7 | **INPUT FILTER MODULE ASSEMBLY** **Figure 5-14 6160A-4101** | 323667 | 89536 | 323667 | REF | | |
| A7A1 | Input Filter PCB Assembly | | | | 1 | | |
| 1 | Module Cover, inner | 323204 | 89536 | 323204 | 1 | | |
| 2 | Module cover, outer | 323212 | 89536 | 323212 | 1 | | |
| 3 | Screw, PNH, Phillips 4 - 40 x ¼ | 129890 | 73734 | 19022 | 7 | | |
| 4 | Nameplate | 329769 | 89536 | 329769 | 1 | | |




igure 5-14. INPUT FILTER MODULE ASSEMBLY, A7

## INPUT FILTER PCB ASSEMBLY, A7A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A7A1 | **INPUT FILTER PCB ASSEMBLY**<br>**Figure 5-15 6160A-4001** | | | | REF | | |
| C1,C2 C3,C6, C7,C8, C11, C13, C16, C18, C21, C22, C25 thru C28 | Cap, cer, 0.05 uf +80/-20%, 25V | 148924 | 72982 | 5855-&5U-5032 | 16 | | |
| C29 thru C31 | Cap, feed-thru, 2500 pf, 500V | 248286 | 04222 | BSF-1BB | 3 | | |
| C4 | Cap, mica, 510 pf ±5%, 500V | 148411 | 53021 | CD15E511J | 1 | | |
| C5 | Cap, mica, 150 pf ±5%, 500V | 148478 | 53021 | CD15F151J | 1 | | |
| C10, C14, C19 | Cap, mica, 220 pf ±5%, 500V | 170423 | 53021 | CD15F221J | 3 | | |
| C12, C17 | Cap, mica, 560 pf ±5%, 500V | 170431 | 53021 | CD19F561J | 2 | | |
| C20 | Cap, mica, 1000 pf ±5%, 500V | 148387 | 53021 | CD19F102J | 1 | | |
| C23 | Cap, mica, 1500 pf ±5%, 500V | 148361 | 53021 | CD19F152J | 1 | | |
| C24 | Cap, mica, 390 pf ±5%, 500V | 148437 | 53021 | CD15F391J | 1 | | |
| CR1 | Diode, silicon, 150 mA | 203323 | 03508 | 1N4148 | 1 | 1 | |
| CR2, CR3 | Diode, germanium, 80 mA, 100 piv | 149187 | 93332 | 1N270 | 2 | 1 | |
| J1 thru J4 | Connector, male, coaxial | 207639 | 13511 | 27-875 | 4 | | |
| L1 | Inductor, 0.75 uh | 204891 | 89536 | 204891 | 1 | | |
| L2 | Coil | 173013 | 89536 | 173013 | 1 | | |
| L3,L4 L7 | Inductor, 1000 uh ±10%, 40 mA | 256107 | 24759 | MR-1000 | 3 | | |

## INPUT FILTER PCB ASSEMBLY, A7A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| L5 | Inductor, 3.3 uh ±5%, 1030 mA | 174714 | 72259 | WEE 3-3 | 1 | | |
| L6 | Bead, | 219535 | 02114 | 56-060-85-38 | 1 | | |
| Q1,Q2 | Tstr, silicon, NPN | 246264 | 95303 | 2N3933 | 2 | 1 | |
| Q3 thru Q7 | Tstr, silicon, NPN | 179374 | 07263 | 2N2218 | 5 | 1 | |
| R1 R6' | Res, comp, 51Ω ±5%, ¼W | 221879 | 01121 | CB5105 | 2 | | |
| R2, R14, R23 | Res, comp, 8.2k ±5%, ¼W | 160796 | 01121 | CB8225 | 3 | | |
| R3, R12 | Res, comp, 1k ±5%, ¼W | 148025 | 01121 | CB1025 | 2 | | |
| R4, R5, R18 | Res, comp, 270Ω ±5%, ¼W | 160804 | 01121 | CB2715 | 3 | | |
| R7 | Res, comp, 3.3k ±5%, ¼W | 148056 | 01121 | CB3325 | 1 | | |
| R8 | Res, var, cermet, 5k ±20%, ½W | 226084 | 80294 | 3329H-1-502 | 1 | | |
| R9, R15 | Res, comp, 5.6k ±5%, ¼W | 148080 | 01121 | CB5625 | 2 | | |
| R10 | Res, comp, 180Ω ±5%, ¼W | 147942 | 01121 | CB 1815 | 1 | | |
| R11 | Res, comp, 33Ω ±5%, ¼W | 175034 | 01121 | CB3305 | | | |
| R13 | Res, comp, 680Ω ±5%, ¼W | 148007 | 01121 | CB6815 | 1 | | |
| R16 | Res, comp, 39Ω ±5%, ¼W | 193391 | 01121 | CB3905 | 1 | | |
| R17 | Res, var, cermet, 100Ω | 193052 | 80294 | 3329H-1-101 | 1 | | |
| R19, R28 | Res, comp, 4.7k ±5%, ¼W | 148072 | 01121 | CB4725 | 2 | | |
| R20, R21 | Res, comp, 12k ±5%, ¼W | 159731 | 01121 | CB1235 | 2 | | |
| R22 | Res, comp, 220Ω ±5%, ¼W | 147959 | 01121 | CB2215 | 1 | | |
| R24, R26, R31 | Res, comp, 100Ω ±5%, ¼W | 147926 | 01121 | CB1015 | 3 | | |
| R25 | Res, var, cermet, 200Ω ±10%, ¼W | 226050 | 01121 | CB2015 | 1 | | |

## INPUT FILTER PCB ASSEMBLY, A7A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R29 | Res, comp, 330Ω ±5%, ¼W | 147967 | 01121 | CB3315 | 1 | | |
| R30 | Res, comp, 560Ω ±5%, ¼W | 147991 | 01121 | CB5615 | 1 | | |
| R32 | Res, comp, 2k ±5%, ¼W | 202879 | 01121 | CB2025 | 1 | | |
| R33 | Res, comp, 150Ω ±5%, ¼W | 147934 | 01121 | CB1515 | 1 | | |
| T1,T2 | Transformer, var, nom, 2.5 uh | 254201 | 89536 | 254201 | 2 | | |
| T3 | Transformer, 4.2 uh | 173021 | 89536 | 173021 | 1 | | |
| U1 | IC, TTL, Quad 2-Input Nand Gate | 292953 | 01295 | SN7400N | 1 | 1 | |
| Y1, Y2 | Crystal, 5 MHz | 255927 | 71450 | H17-019-0589 | 2 | | |
| | Holder, crystal | 148668 | 91506 | 8000-AG-10 | 2 | | |
| | Socket, IC, 14 contact | 276527 | 23880 | TSA-2900-14W | 2 | | |
| | Spacer, Xstr mtg. Pad T 0-5 | 152207 | Milton Ross | 10123-DAP | 5 | | |

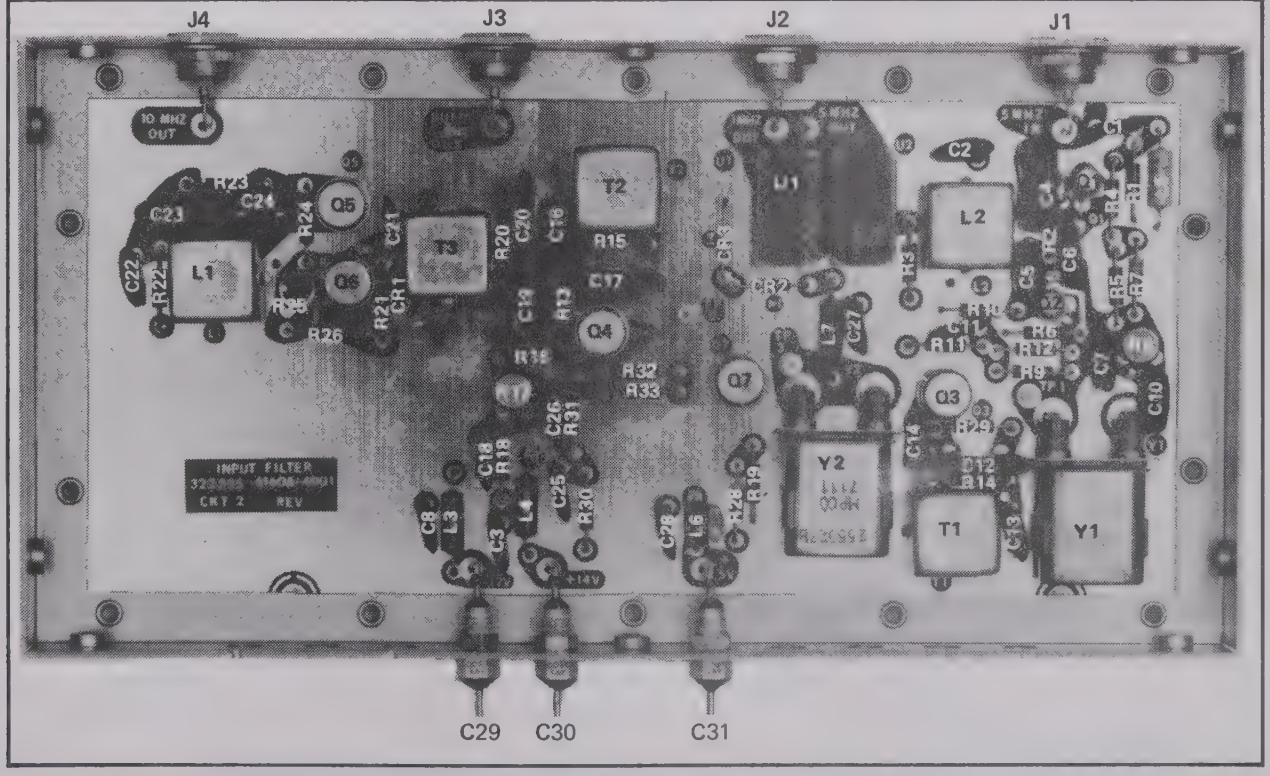



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Figure 5-15. INPUT FILTER PCB ASSEMBLY, A7A1

## 1 MHz DIGIT GENERATOR MODULE SET ASSEMBLY, A8

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| **A8** | **1 MHz DIGIT GENERATOR MODULE SET ASSEMBLY**<br>**Figure 5-16 6160B-4153** | 356444 | 89536 | 356444 | REF | | |
| A8A1 | 1 MHz Digit Matched Module Pair Assembly - 6160B-4153–1 and –2 | | | | 1 | | |
| A8A2 | Main Loop Phase Detector Module Assembly - 6160B-4153-3 | | | | 1 | | |
| 1 | Joiner, module set | 356469 | 89536 | 356469 | 2 | | |
| 2 | Screw, 4 - 40 x ¼ PNH Phillips | 129890 | 73734 | 19022 | 6 | | |

*NOTE*

*A8A1 and A8A2 comprise a module set, and are procurable only as a complete and tested assembly. Also note that A8A1 comprises two separate, but electrically matched, modules.*

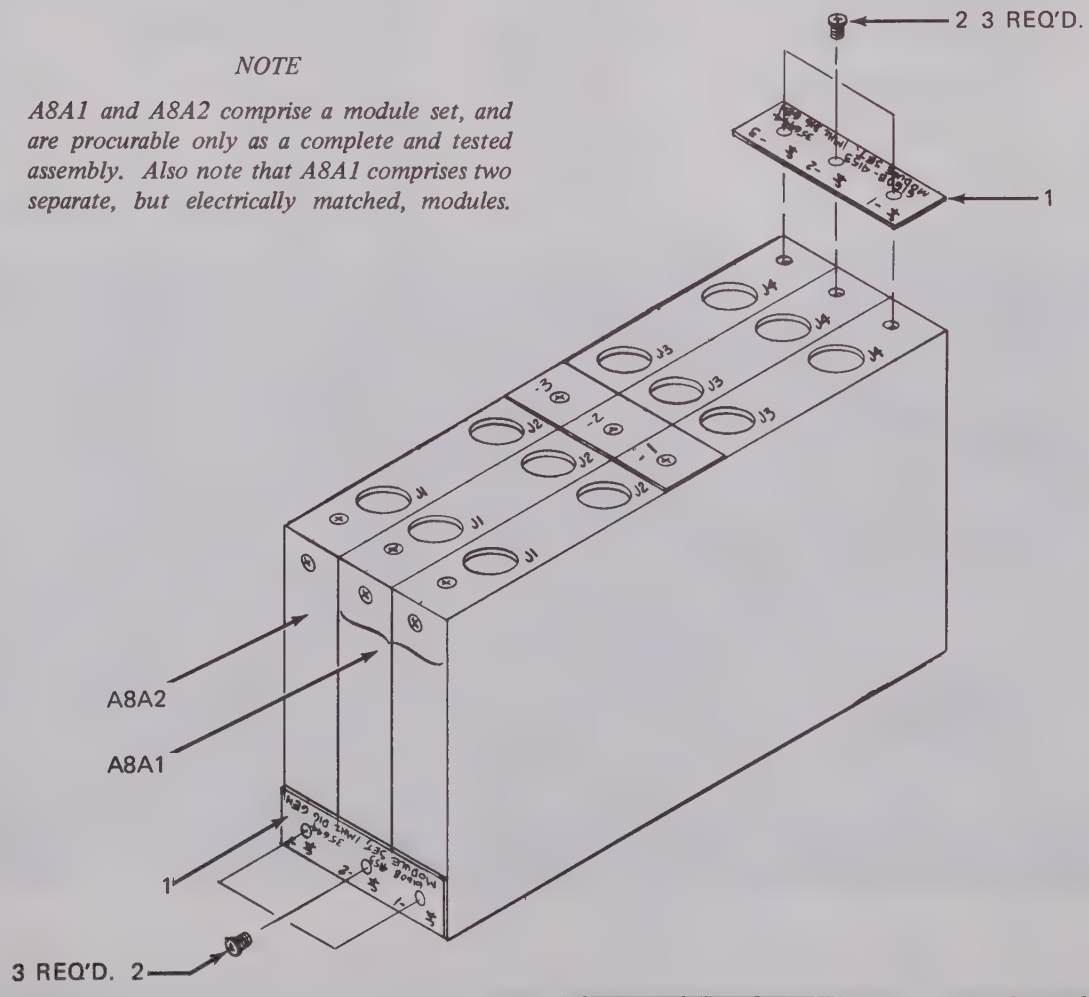


Figure 5-16. 1 MHz DIGIT GENERATOR MODULE SET ASSEMBLY, A8

## 1 MHz MATCHED MODULE PAIR ASSEMBLY, A8A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A8A1 | **1 MHz MATCHED MODULE PAIR ASSEMBLY**<br>**Figure 5-17 6160B-4153-1, -2** | | | | REF | | |
| A8A1A1 | 1 MHz Step Loop PCB Assembly 6040A-4003 | | | | 1 | | |
| A8A1A2 | Main Loop VCO PCB Assembly 6160B-4005 | | | | 1 | | |
| A8A1A1 CR2, A8A1A1 CR3, A8A1A2 CR1 A8A1A2 CR2 | Diode, Pair matched set (not illustrated)<br>*NOTE!*<br>*When replacing A8A1A1 or A8A1A2 pcb's, two diode pair sets will have to be ordered separately. One diode from each set will have to be installed in the A8A1A1 pcb and the remaining diode of each set will be installed in the A8A1A2 pcb.* | 347534 | 89536 | 347534 | 2 | | |
| 1 | Cover, inner | 323204 | 89536 | 323204 | 2 | | |
| 2 | Cover, outer | 323212 | 89536 | 323212 | 2 | | |
| 3 | Screw, 4 - 40 x ¼ PNH Phillips | 129890 | 73734 | 19022 | 10 | | |
| 4 | Nameplate, -1 Assembly | 367144 | 89536 | 367144 | 1 | | |
| 5 | Nameplate, -2 Assembly | 356378 | 89536 | 356378 | 1 | | |

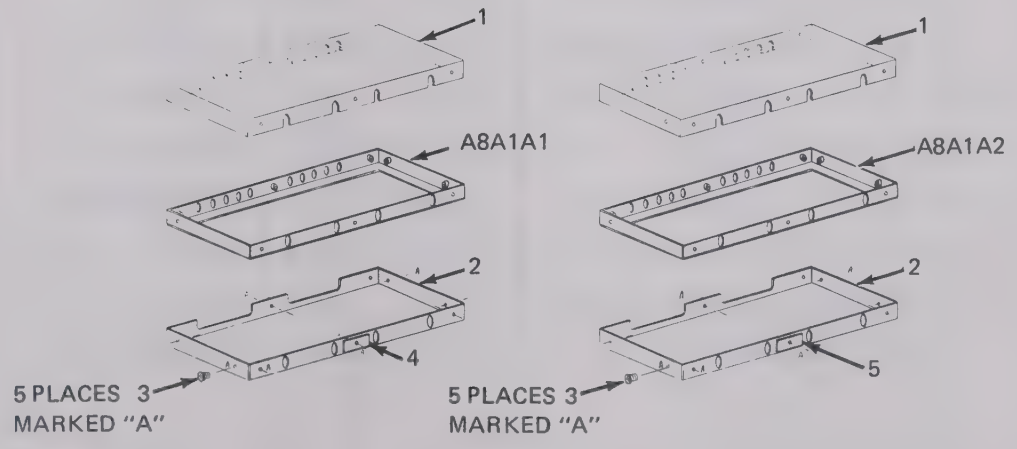


Figure 5-17. 1 MHz MATCHED MODULE PAIR ASSEMBLY, A8A1

## 1 MHz STEP LOOP PCB ASSEMBLY, A8A1A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A8A1A1 | **1 MHz STEP LOOP PCB ASSEMBLY Figure 5-18 6040A-4003** | | | | REF | | |
| C1,C2 | Cap, tant, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | 14 | | |
| C3 | Cap, cer, 0.0012 uf, ±10%, 500V | 106732 | 71590 | CF-122 | 6 | | |
| C4,C5 | Cap, tant, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C6 | Cap, mica, 560 pf, ±5%, 500V | 170431 | 53021 | D19F561J | 1 | | |
| C7 | Cap, tant, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C8 | Cap, mica 4 pf, ±5%, 500V | 190397 | 53021 | D15C040K | 2 | | |
| C9,C10 | Cap, cer, 0.0012uf, ±10%, 500V | 106732 | 71590 | CF-122 | REF | | |
| C11 | Cap, mica, 18pf, ±5%. 500V | 266585 | 53021 | D15C180J | 1 | | |
| C12 | Cap, tant, 2.2 uf ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C13 | Cap, cer, 0.0012 uf, ±10%, 500V | 106732 | 71590 | CF-122 | REF | | |
| C14 | Cap, mica, 33 pf, ±10%, 500V | 160317 | 53021 | D15E330J | 1 | | |
| C15 | Cap, cer, 0.0012 uf, ±10%, 500V | 106732 | 71590 | CF-122 | REF | | |
| C16 | Cap, mica, 270pf, ±5%, 500V | 148452 | 53021 | D15F271J | 1 | | |
| C17,C18 | Cap, tant, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C19 | Cap, var cer, 4.5 to 50 pf,+70/-20%,250V | 321117 | 73899 | DVJ305A | 1 | | |
| C20 | Cap, mica, 1110 pf, ±1%, 500V | 170415 | 53021 | D15F111F | 1 | | |
| C21 | Cap, mica, 330 pf, ±5%, 500V | 148445 | 53021 | D15F331J | 1 | | |
| C22 | Cap, var cer, 1.7 to 10 pf,+70/-20%,250V | 321109 | 73899 | DVJ302A | 1 | | |
| C23 | Cap, mica, 47 pf, ±5%, 500V | 148536 | 53021 | D15E470J | 1 | | |
| C24,C26 | Cap, mica, 390 pf, ±5%, 500V | 148437 | 53021 | D15E391J | 2 | | |
| C25,C27 | Cap, tant, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C28 | Cap, cer, 0.0012 uf, ±10%, 500V | 106732 | 71590 | CF-122 | REF | | |
| C29 | Cap, fxd, plstc, diel 0.22 uf, ±10%, 50V | 271577 | 06001 | 75F1R5A222 | 1 | | |
| C30, C32 thru C34 | Cap, tant, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C31,C36 | Cap, cer, 0.05uf, +80/-20%, 25V | 148924 | 72982 | 5855-Y5U-503Z | 2 | | |

## 1 MHz STEP LOOP PCB ASSEMBLY, A8A1A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| C35 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101 F103M | 1 | | |
| C37 | Cap, mica, 4 pf, ±5%, 500V | 190397 | 53021 | D15C040K | REF | | |
| C38 thru C46 | Cap, feed-thru | 248286 | 00656 | BSF-1BB | 9 | | |
| CR2, CR3 | Diode pair, matched set<br>*NOTE!*<br>*Varactor tuning diodes CR2 and CR3 are matched to CR1 and CR2 in the 1 MHz Main Loop VCO PCB Assembly, A8A1A2. If replacement is required, two matched sets must be ordered. When replacing these diodes, install one diode from each set in the A8A1A1 pcb assembly. Install the remaining diodes of each set in the A8A1A2 pcb assembly.* | 347534 | 89536 | 347534 | REF | | |
| CR4 | Diode, si,150mA | 203323 | 03508 | 1N4148 | 1 | 1 | |
| J1 thru J4 | Conn, male, coax. | 207639 | 13511 | 27-875 | 4 | | |
| L1 | Choke, 6 turn | 320911 | 89536 | 320911 | 11 | | |
| L2 | Inductor, Type 10K | 339234 | 89536 | 339234 | 1 | | |
| L3 | Choke, RF, 270 uh ±5%, 260 mA | 186270 | 72259 | WEE-270 | 1 | | |
| L4,L5 | Choke, 6 turn | 320911 | 89536 | 320911 | REF | | |
| L6 | Choke, RF, 180 uh, ±5%, 300 mA | 174771 | 72259 | WEE-180 | 1 | | |
| L7 | Choke, 6 turn | 320911 | 89536 | 320911 | REF | | |
| L8 | Choke, RF, 120 uh, ±10%, 330 mA | 321042 | 72259 | WEE-120 | 1 | | |
| L9 thruL14 L16 | Choke, 6 turn | 320911 | 89536 | 320911 | REF | | |
| Q2 thru Q5 | Xstr, si, NPN | 248351 | 04713 | MPS918 | 4 | 1 | |

## 1 MHz STEP LOOP PCB ASSEMBLY, A8A1A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| Q6, Q8, Q10,Q11 | Xstr, si, PNP | 229898 | 04713 | MPS6522 | 4 | 1 | |
| Q7, Q9 | Xstr., si, NPN | 281081 | 04713 | MPS6520 | 2 | 1 | |
| R2 | Res, comp, 680Ω, ±5%, ¼W | 148007 | 01121 | CB6805 | 2 | | |
| R3,R4 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | 5 | | |
| R5 | Res, comp, 200Ω, ±5%, ¼W | 193482 | 01121 | CB2015 | 1 | | |
| R6 | Res, comp, 470Ω, ±5%, ¼W | 147983 | 01121 | CB4715 | 1 | | |
| R8 | Res, comp, 1K, ±5%, ¼W | 148023 | 01121 | CB1025 | 5 | | |
| R9 thru R11 | Res, comp, 120Ω, ±5%, ¼W | 170712 | 01121 | CB1215 | 3 | | |
| R12 | Res, comp, 1.5K, ±5%, ¼W | 148031 | 01121 | CB1525 | 2 | | |
| R13 | Res, comp, 1K, ±5%, ¼W | 148023 | 01121 | CB1025 | REF | | |
| R14 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R15 | Res, comp, 1.5K, ±5%, ¼W | 148031 | 01121 | CB1525 | REF | | |
| R16 | Res, comp, 1K, ±5%, ¼W | 148023 | 01121 | CB1025 | REF | | |
| R17 | Res, comp, 4.7K, ±5%, ¼W | 148072 | 01121 | CB4725 | 2 | | |
| R18 | Res, comp, 8.2K, ±5%, ¼W | 160796 | 01121 | CB8225 | 3 | | |
| R19 | Res, comp, 1.2K, ±5%, ¼W | 190371 | 01121 | CB1225 | 1 | | |
| R20 | Res, met flm, 649Ω, ±1%, 1/8W | 309955 | 91637 | MFF1-86490F | 1 | | |
| R21 | Res, comp, 4.7K, ±5%. ¼W | 148072 | 01121 | CB4725 | REF | | |
| R22 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R23,R24 | Res, comp, 1K, ±5%, ¼W | 148023 | 01121 | CB1025 | REF | | |
| R25 | Res, comp, 270Ω, ±5%, ¼W | 160804 | 01121 | CB2715 | 1 | | |
| R26 | Res, comp, 330Ω, ±5%, ¼W | 147967 | 01121 | CB3315 | 1 | | |
| R27,R28 | Res, comp, 8.2K, ±5%, ¼W | 160796 | 01121 | CB8225 | REF | | |
| R29 | Res, comp, 1.8K, ±5%, ¼W | 175042 | 01121 | CB1825 | 1 | | |
| R30 | Res, comp, 3.3K, ±5%, ¼W | 148056 | 01121 | CB3325 | 1 | | |
| R31 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R32 | Res, comp 220Ω, ±5%, ½W | 186031 | 01121 | EB2215 | 1 | | |

## 1 MHz STEP LOOP PCB ASSEMBLY

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R33 | Res, comp, 680Ω, ±5%, ¼W | 148007 | 01121 | CB6805 | REF | | |
| R34 | Res, comp, 47Ω, ±5%, ¼W | 147892 | 01121 | CB4705 | 1 | | |
| R35 | Res, comp, 39Ω ±5%, ¼W | 193391 | 01121 | CB3905 | 1 | | |
| U1 | IC, TTL, triple 3-input pos AND gate, active pull-up. | 363457 | 01295 | SN74S11N | 2 | 1 | |
| U2 | IC, TTL, Quad 2-input +NAND gates | 293068 | 01295 | SN74H00P | 2 | 1 | |
| U3 | IC, Operational amplifier | 271502 | 07263 | LM301A | 1 | 1 | |
| U4 | IC, TTL, 35MHz, pre-set decade/binary ctr. | 320747 | 01295 | SN74176N | 1 | 1 | |
| U5 | IC, TTL, phase-frequency detector | 320721 | 04713 | MC4044P | 1 | 1 | |
| U6 | IC, TTL, dual J-K edge trig, flip-flop. | 363440 | 01295 | SN 74S112N | 1 | 1 | |
| U7 | IC, TTL, triple 3-input pos. AND gate, w/active pull-up. | 363457 | 01295 | SN74S11N | REF | | |
| U8 | IC, TTL SSI, dual J-K neg. edge trig flip-flop w/preset & clear. | 293100 | 01295 | SN74H106N | 1 | 1 | |
| U9 | IC, TTL, 50 MHz, Decade counter | 320754 | 01295 | SN74196N | 1 | 1 | |
| U10 | IC, TTL, Quad 1-input +NAND gates | 293068 | 01295 | SN74H00P | REF | | |
| U11 | IC, DTL SSI Hex Inverter | 268367 | 04713 | MC836P | 1 | | |

## 1 MHz STEP LOOP PCB ASSEMBLY, A8A1A1

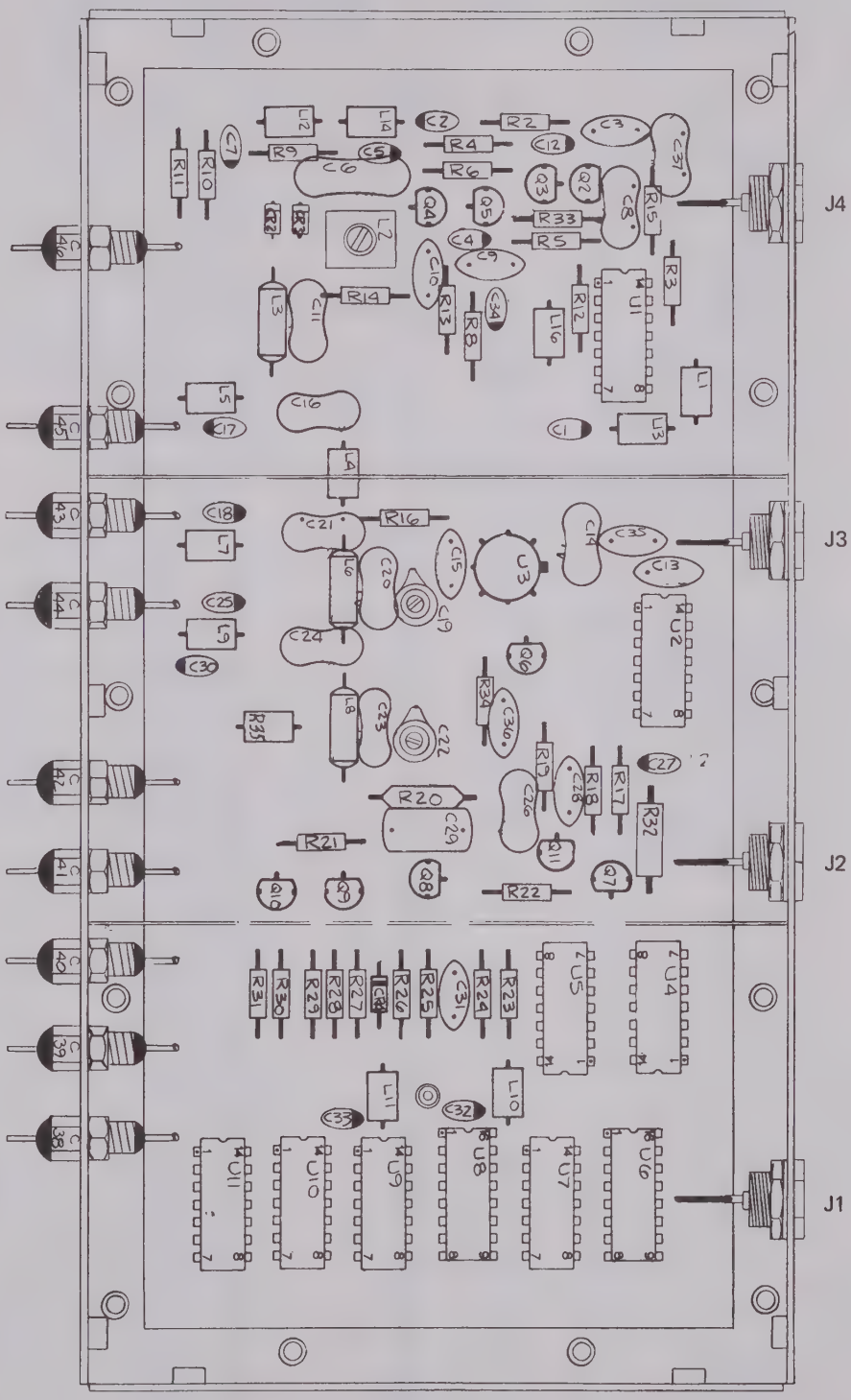


Figure 5-18. 1 MHz STEP LOOP PCB ASSEMBLY, A8A1A1

## 1 MHz MAIN LOOP VCO PCB ASSEMBLY, A8A1A2

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A8A1A2 | **1 MHz MAIN LOOP VCO PCB ASSEMBLY**<br>**Figure 5-19 6160B-4005** | | | | REF | | |
| C1 | Cap, mica, 150 pf, ±5%, 500V | 148478 | 53021 | D15F151J | 3 | | |
| C2,C3 | Cap, mica, 220 pf, ±5%, 500V | 170423 | 53021 | D15F221J | 4 | | |
| C4 | Cap, tant, 2.2uf, ±20%, 20V | 161927 | 56289 | 96D225X0020 | 9 | | |
| C5,C6, C7 | Cap, cer, 0.0012 uf, ±10%, 500V | 106732 | 71590 | CF-122 | 7 | | |
| C8 | Cap, mica, 150 pf, ±5%, 500V | 148478 | 53021 | D15F151J | REF | | |
| C9, C37 | Cap, cer, 0.01 uf, ±20%, 100V | 149153 | 56289 | C023B101 F103M | 2 | | |
| C10 | Cap, mica, 110 pf, ±1%, 500V | 170415 | 53021 | D15F111F | 1 | | |
| C11 | Cap, mica, 5 pf, ±10%, 500V | 148577 | 53021 | D15C050K | 1 | | |
| C12 | Cap, cer, 0.024 uf, ±20%, 100V | 168435 | 56289 | C023B101H 253M | 1 | | |
| C13 | Cap, mica, 150 pf, ±5%, 500V | 148178 | 53021 | D15F151J | REF | | |
| C14 | Cap, cer, 0.0012 uf, ±10%, 500V | 106732 | 71590 | CF-122 | REF | | |
| C15 | Cap, mica, 62 pf, ±5%, 500V | 276469 | 53021 | D15F620J | 1 | | |
| C17 | Cap, mica, 51 pf, ±5%, 500V | 277210 | 53021 | D15E5101J | 1 | | |
| C18, C19 | Cap, mica, 220 pf, ±5%, 500V | 170423 | 53021 | D15F221J | REF | | |
| C21 | Cap, mica, 30 pf, ±5%, 500V | 340570 | 53021 | D155E300JP | 1 | | |
| C22 | Cap, mica, 560 pf, ±5%, 500V | 170431 | 53021 | D19F561J | 1 | | |
| C23 | Cap, cer, 0.0012 uf, ±10%, 500V | 106731 | 71590 | CF-122 | REF | | |
| C24 thru C27 | Cap, tant, 2.2 uf, ±20%, 20V | 161927 | 56289 | 96D225X0020 | REF | | |
| C29 | Cap, cer, 0.0012 uf, ±10%, 500V | 106732 | 71590 | CF-122 | REF | | |
| C30 | Cap, mica, 4 pf, ±5%, 500V | 190397 | 53021 | D15C040K | 1 | | |
| C32 | Cap, tant, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C33 | Cap, cer, 0.0012 uf, ±10%, 500V | 106732 | 71590 | CF-122 | REF | | |
| C34, C35, C36 | Cap, tant, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |

## 1 MHz MAIN LOOP VCO PCB ASSEMBLY, A8A1A2

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| C38,C39 C40,C41 | Cap, feed-thru, 2500 pf | 248286 | 00656 | BSF-1BB | 4 | | |
| CR1, CR2 | Diode pair, matched set | 347534 | 89536 | 347534 | REF | | |
| | *NOTE!*<br>*Varactor tuning diodes CR1 and CR2 are matched to CR2 and CR3 in the 1 MHz Step Loop PCB Assembly, A8A1A1. If replacement is required, two matched sets must be ordered. When replacing these diodes, install one diode from each set in the A8A1A2 pcb assembly. Install the remaining diodes of each set in the A8A1A1 pcb assembly.* | | | | | | |
| L1, L3 | Choke, RF, 0.33 uh, ±20%, 1900mA | 207605 | 72259 | WEE - .33 | 2 | | |
| L2 | Choke, RF, 0.27 uh, ±20%, 2000 mA | 321018 | 72259 | WEE - .27 | 1 | | |
| L4 | Choke, RF, 22 uh, ±20%, 590mA | 147843 | 72259 | WEE - 22 | 1 | | |
| L5 | Choke, RF, 120 uh, ±10%, 330mA | 321042 | 72259 | WEE 120 | 1 | | |
| L6 | Choke, 6 turn | 320911 | 89536 | 320911 | 7 | | |
| L8 | Inductor, Type 10K, .7-1.3 uh at 7.9 MHz | 339234 | 89536 | 339234 | 1 | | |
| L9,L10, L11,L13, L14,L15 | Choke, 6 turn | 320911 | 89536 | 320911 | REF | | |
| J1 thru J4 | Conn, male, coax | 207639 | 13511 | 27-875 | 4 | | |
| Q1 thru Q4 | Xstr, si, NPN | 248351 | 04713 | MPS918 | 4 | 1 | |
| R1 | Res, comp, 820Ω, ±5%, ¼W | 148015 | 01121 | CB8215 | 3 | | |
| R2,R3 | Res, comp, 56Ω, ±5%, ¼W | 147900 | 01121 | CB5605 | 2 | | |
| R4,R20 | Res, comp, 180Ω, ±5%, ¼W | 147942 | 01121 | CB1815 | 2 | | |
| R5 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | 1 | | |
| R6,R7 | Res, comp, 1K, ±5%, ¼W | 148023 | 01121 | CB1025 | REF | | |
| R8 | Res, comp, 470Ω, ±5%, ¼W | 147983 | 01121 | CB4715 | 1 | | |
| R9 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R10 | Res, comp, 120Ω, ±5%. ¼W | 170712 | 01121 | CB1215 | 1 | | |
| R11 | Res, comp, 200Ω, ±5%, ¼W | 193482 | 01121 | CB2015 | 1 | | |

## 1 MHz MAIN LOOP VCO PCB ASSEMBLY, A8A1A2

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R12 | Res, comp, 2K, ±5%, ¼W | 202879 | 01121 | CB2025 | 1 | | |
| R13 | Res, comp, 1K, ±5%, ¼W | 148023 | 01121 | CB1025 | REF | | |
| R14, R15 | Res, comp, 1.5K, ±5%, ¼W | 148031 | 01121 | CB1525 | 2 | | |
| R16 | Res, comp, 150Ω, ±5%, ¼W | 147934 | 01121 | CB1515 | 1 | | |
| R17 | Res, comp, 47Ω, ±5%, ¼W | 147892 | 01121 | CB4705 | 1 | | |
| R18 | Res, comp, 820Ω, ±5%, ¼W | 148015 | 01121 | CB8215 | REF | | |
| R19 | Res, comp, 270Ω, ±5%, ¼W | 160804 | 01121 | CB2715 | 1 | | |
| R21 | Res, comp, 820Ω, ±5%, ¼W | 148015 | 01121 | CB8215 | REF | | |
| R22 | Res, comp, 27Ω, ±5%, ¼W | 160812 | 01121 | CB2705 | 1 | | |
| U1 | IC, Linear 4 quadrant multi, dbl-bal. mixer | 363762 | 01295 | SN76514N | 1 | 1 | |
| U2 | IC, TTL, triple 3-input pos. AND gate | 363457 | 01295 | SN74S11N | 1 | 1 | |
| U3 | IC, MECL 70 MHz, AC coupled, J-K flip-flop | 226340 | 04713 | MC1013P | 1 | 1 | |

# 1 MHz MAIN LOOP VCO PCB ASSEMBLY, A8A1A2

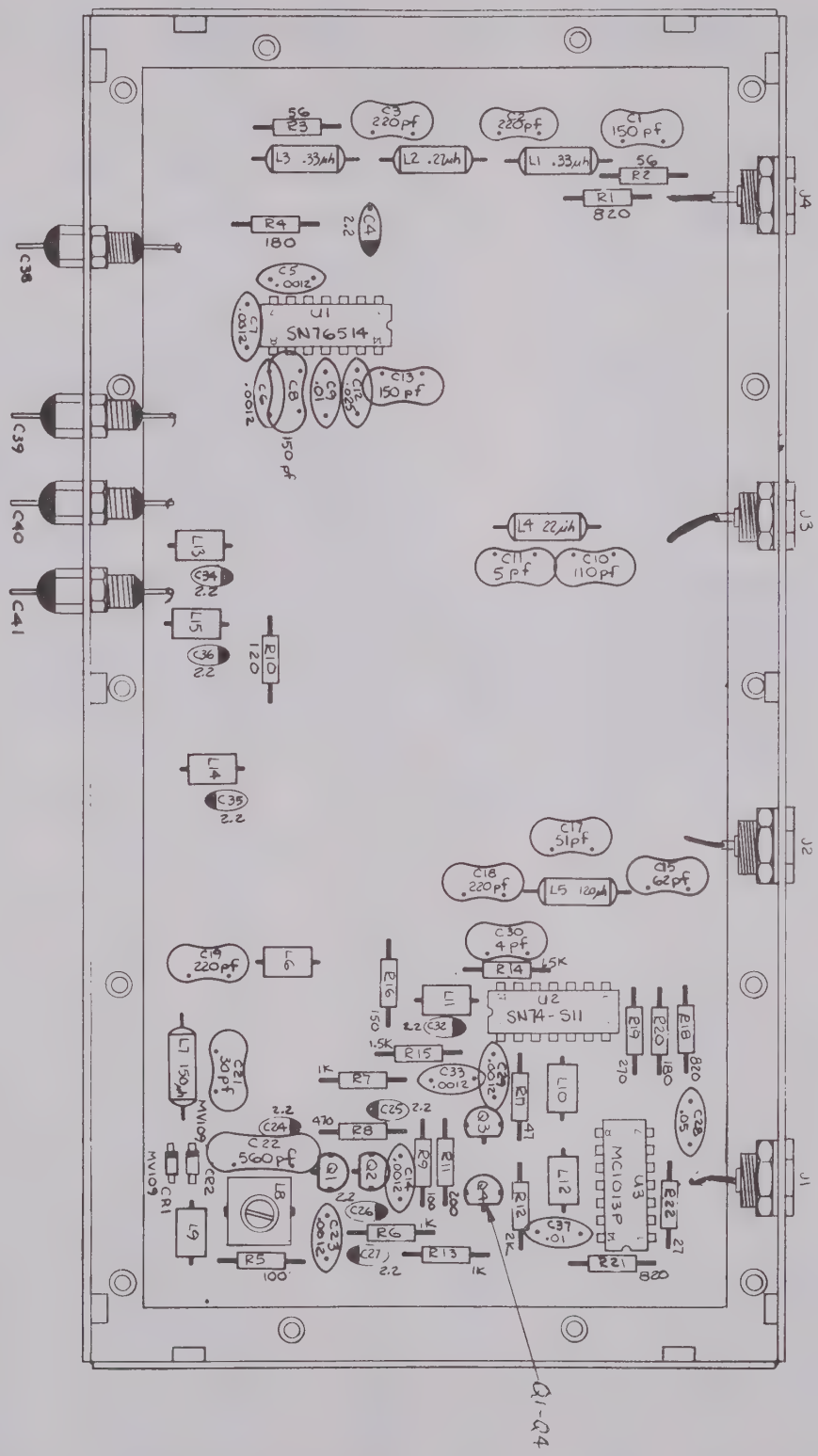


Figure 5-19. 1 MHz MAIN LOOP VCO PCB ASSEMBLY, A8A1A2

## 1 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY, A8A2

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A8A2 | **1 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY** **Figure 5-20 6160B-4153-3** | | | | REF | | |
| A8A2A1 | Main Loop Phase Detector PCB Assembly 6040A-4004 | | | | 1 | | |
| 1 | Cover, inner | 323204 | 89536 | 323204 | 1 | | |
| 2 | Cover, outer | 323212 | 89536 | 323212 | 1 | | |
| 3 | Screw, 4 - 40 x ¼ PNH Phillips | 129890 | 73234 | 19022 | 5 | | |
| 4 | Nameplate, -3 Assembly | 367169 | 89536 | 367169 | 1 | | |

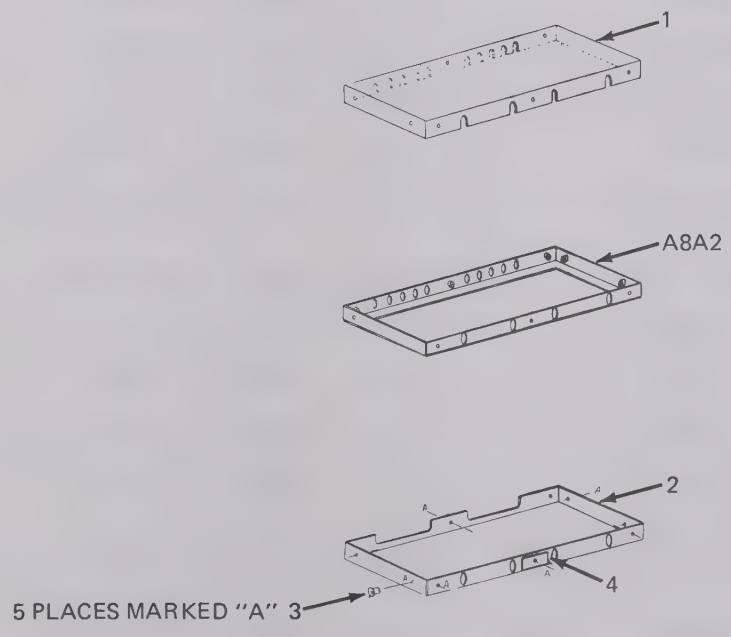


Figure 5-20. 1 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY, A8A2

## 1 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A8A2A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A8A2A1 | **1 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY**<br>**Figure 5-21 6040A-4004** | 364919 | 89536 | 364919 | REF | | |
| C1,C2, C3 | Cap, tant, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | 8 | | |
| C4 | Cap, Fxd, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F 103M | 4 | | |
| C5 | Cap, mica, 33 pf, ±5%, 500V | 160317 | 53021 | D15E330J | 1 | | |
| C6,C7 | Cap, Fxd, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F 103M | REF | | |
| C8 | Cap, tant, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C9 | Cap, fxd, cer, 0.025 uf, ±20%, 100V | 168435 | 56289 | C023D101M 253M | 3 | | |
| C10 | Cap, Fxd plstc, diel, 0.22 uf, ±10%, 50V | 271577 | 06001 | 75FIR5A222 | 1 | | |
| C11 | Cap, mica, 22 pf, ±5%. 500V | 148551 | 53021 | D15E220J | 1 | | |
| C12 | Cap, mica, 51 pf, ±5%, 500V | 277210 | 53021 | D15E510J | 1 | | |
| C13 | Cap, mica, 120 pf, ±5%, 500V | 148486 | 53021 | D15F121J | 1 | | |
| C14 | Cap, mica, 62 pf, ±5%, 500V | 276469 | 53021 | D15F620J | 1 | | |
| C15, C16 | Cap, tant, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C17 | Cap, fxd cer, 680 pf, ±10%, 2000V | 207530 | 72982 | 801X5F681K | 1 | | |
| C18 | Cap, mica, 110pf, ±1%, 500V | 170415 | 53021 | D15F111F | 1 | | |
| C19 | Cap, mica, 2 pf, ±5%, 500V | 175208 | 53021 | D15E020J | 1 | | |
| C20 | Cap, mica, 150 pf, ±5%, 500V | 148478 | 53021 | D15F151J | 1 | | |
| C21 | Cap, fxd, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F 103M | 4 | | |
| C22, C23 | Cap, fxd, cer, 0.025 uf, ±20%, 100V | 168435 | 56289 | C023D101M 253M | REF | | |
| C24, C25 | Cap, tant, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | 8 | | |
| C26, C27, C28 | Cap, feed-thru | 248286 | 00656 | BSF-1BB | 3 | | |

## 1 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A8A2A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| CR1, CR2, CR3 | Diode, si, 150mA | 203323 | 03508 | 1N4148 | 3 | 1 | |
| J1 thru J4 | Conn, male, coax. | 207639 | 13511 | 27-875 | 4 | | |
| L1 thru L5 | Choke, 6-turn | 320911 | 89536 | 320911 | 9 | | |
| L6 | Inductor | 363143 | 89536 | 363143 | 1 | | |
| L7 | Choke, 6-turn | 320911 | 89536 | 320911 | REF | | |
| L8 | Choke, RF | 147843 | 72259 | WEE-22 | 1 | | |
| L9 thru L11 | Choke, 6-turn | 320911 | 89536 | 320911 | REF | | |
| Q1 | Xstr, si, PNP, dual | 242016 | 04713 | QD401-78E | 1 | 1 | |
| Q2 | Xstr, si, NPN | 281081 | 04783 | MPS6520 | 3 | 1 | |
| Q3, Q4 | Xstr, si, PNP | 229898 | 04713 | MPS6522 | 2 | 1 | |
| Q5, Q6 | Xstr, si, NPN | 218081 | 04713 | MPS6520 | REF | | |
| R1,R2 | Res, comp, 3.3K, ±5%, ¼W | 148056 | 01121 | CB3325 | 2 | | |
| R3 | Res, comp, 11K, ±5%, ¼W | 221580 | 01121 | CB1135 | 1 | | |
| R4 | Res, comp, 1K, ±5%, ¼W | 148023 | 01121 | CB1025 | 4 | | |
| R5 | Res, var, Cermet, 5K, ±20%, 200V | 226076 | 80294 | 3329H1502 | 1 | | |
| R6 | Res, comp, 2.2K, ±5%, ¼W | 148049 | 01121 | CB2225 | 2 | | |
| R7 | Res, comp, 47Ω, ±5%, ¼W | 147892 | 01121 | CB4705 | 1 | | |
| R8, R9 | Res, comp, 12K, ±5%, ¼W | 159731 | 01121 | CB1235 | 2 | | |
| R10 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | 2 | | |

## 1 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A8A2A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R11 | Res, comp, 3.9K, ±5%, ¼W | 148064 | 01121 | CB3925 | 1 | | |
| R12 | Res, comp, 4.7K, ±5%, ¼W | 148072 | 01121 | CB4725 | 2 | | |
| R13 | Res, comp, 8.2K, ±5%, ¼W | 160796 | 01121 | CB8225 | 2 | | |
| R14 | Res, comp, 620Ω, ±5%, ¼W | 221903 | 01121 | CB6215 | 1 | | |
| R15 | Res, comp, 2.2K, ±5%, ¼W | 148049 | 01121 | CB2225 | REF | | |
| R16, R17 | Res, comp, 1K, ±5%, ¼W | 148023 | 01121 | CB1025 | REF | | |
| R18 | Res, comp, 820Ω, ±5%, ¼W | 148015 | 01121 | CB8215 | 1 | | |
| R19 | Res, comp, 1K, ±5%, ¼W | 148023 | 01121 | CB1025 | REF | | |
| R20 | Res, comp, 47K, ±5%, ¼W | 148163 | 01121 | CB4735 | 1 | | |
| R21 | Res, comp, 4.7K, ±5%, ¼W | 148072 | 01121 | CB4725 | REF | | |
| R22 | Res, comp, 8.2K, ±5%, ¼W | 160796 | 01121 | CB8225 | REF | | |
| R23 | Res, comp, 51Ω, ±5%, ¼W | 221879 | 01121 | CB5105 | 1 | | |
| R24 | Res, comp, 1.5K, ±5%. ¼W | 148031 | 01121 | CB1525 | 3 | | |
| R25, R26 | Res, comp, 10K, ±5%, ¼W | 148106 | 01121 | CB1035 | 2 | | |
| R27 | Res, comp, 15Ω, ±5%, ¼W | 147876 | 01121 | CB1505 | 1 | | |
| R28 | Res, comp 430Ω, ±5%, ¼W | 203869 | 01121 | CB4315 | 1 | | |
| R29, R30 | Res, comp, 1.5K, ±5%, ¼W | 148031 | 01121 | CB1525 | REF | | |
| R31 | Res, comp 27Ω, ±5%, ¼W | 160812 | 01121 | CB2705 | 1 | | |
| R32 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| U1 | IC, operational amplifier | 271502 | 07263 | LM301A | 1 | 1 | |
| U2 | IC, TTL, 50 MHz, decade counter | 320754 | 01295 | SN74196N | 1 | 1 | |
| U3 | IC, TTL,phase frequency detector | 320721 | 04713 | MC4044P | 1 | 1 | |
| U4 | IC, TTL, quad 2-input +NAND gates | 293068 | 01295 | SN74H00P | 1 | 1 | |

# 1 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A8A2A1

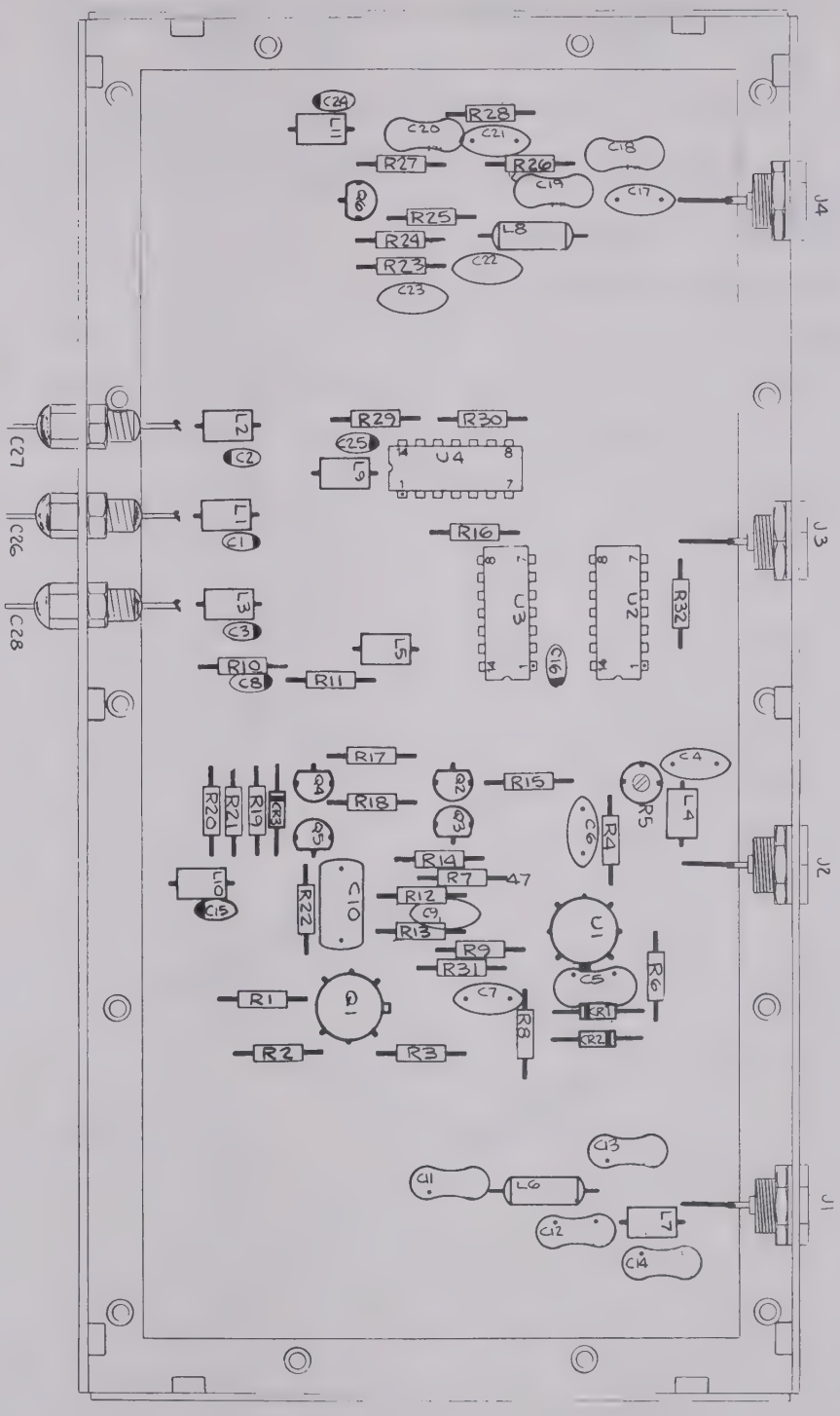


Figure 5-21. 1 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A8A2A1

## SIX DIGIT GENERATOR MODULE ASSEMBLY, A9

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A9 | SIX DIGIT GENERATOR MODULE ASSEMBLY<br>Figure 5-22 6040A - 4102 | 367094 | 89536 | 367094 | REF | | |
| A9A1 | Six Digit Generator PCB Assembly | | | | 1 | | |
| 1 | Cover, inner | 365031 | 89536 | 365031 | 1 | | |
| 2 | Cover, outer | 365049 | 89536 | 365049 | 1 | | |
| 3 | Screw, 4 - 40 x ¼, PNH - Phillips | 129890 | 73734 | 19022 | 5 | | |
| 4 | Nameplate | 367136 | 89536 | 367136 | 1 | | |

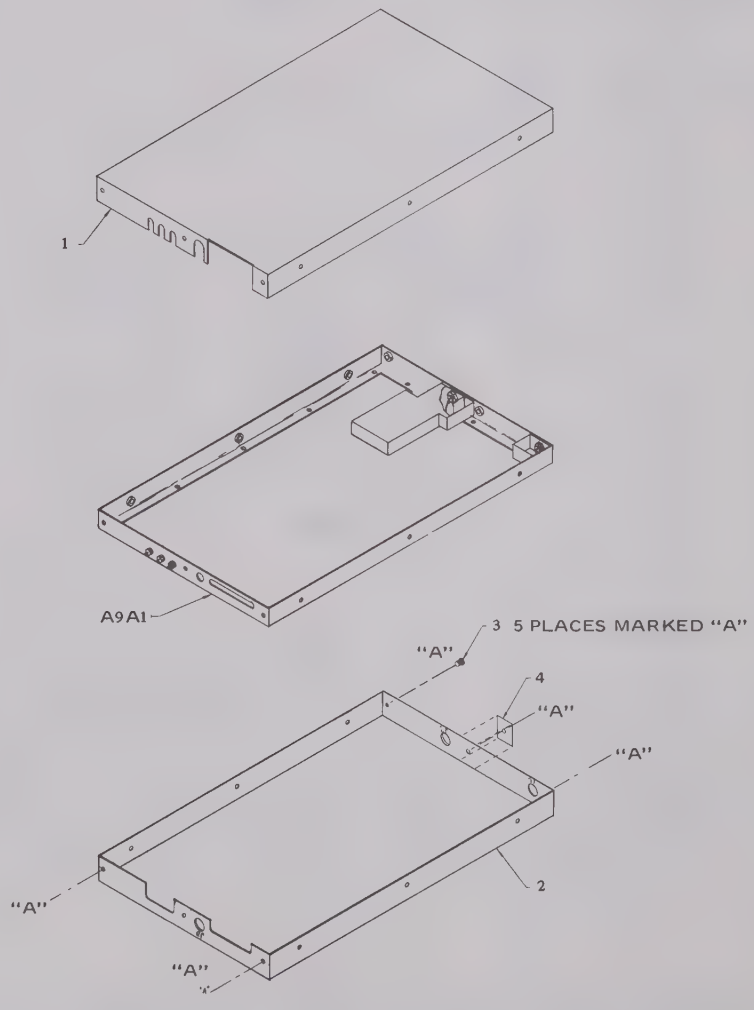


Figure 5-22. SIX DIGIT GENERATOR MODULE ASSEMBLY, A9

## SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A9A1 | SIX DIGIT, GENERATOR PCB ASSY. Figure 5-23 6040A-4002 | | | | REF | | |
| C1 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | 28 | | |
| C2 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | 18 | | |
| C4 | Cap, cer, 0.01uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C5 | Cap, mica, 1000 pf, ±5%, 500V | 148387 | 53021 | D19FD102J03 | 3 | | |
| C6 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C7 | Cap, mica, 360 pf, ±5%, 500V | 325878 | 53021 | D15FD361J03 | 1 | | |
| C8 | Cap, mica, 1200 pf, ±5%, 500V | 148379 | 53021 | D19FD122J03 | 2 | | |
| C9 | Cap, mica, 390 pf, ±5%, 500V | 148437 | 53021 | D15FD391J03 | 3 | | |
| C10 | Cap, mica, 1200 pf, ±5%, 500V | 148379 | 53021 | D19FD122J03 | REF | | |
| C11 | Cap, mica, 18 pf, ±5%, 500V | 266585 | 53021 | D15CD180J03 | 1 | | |
| C12 | Cap, mica, 390 pf, ±5%, 500V | 148437 | 53021 | D15FD391J03 | REF | | |
| C13 | Cap, cer, 300 pf, ±10%, 500V | 105734 | 71590 | BB60301KW7W | 1 | | |
| C14 | Cap, mica, 33 pf, ±5%, 500V | 160317 | 53021 | D15ED330J03 | 3 | | |
| C15, C16 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | 24 | | |
| C17 | Cap, plstc, 0.033 uf, ±10%, 250V | 234492 | 73445 | C280AE/A33K | 1 | | |
| C18 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C19 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C20, C21, C22, C23, C24 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C25 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C26 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C27 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C28 | Cap, mica, 1300 pf, ±5%, 500V | 182881 | 53021 | D19FD1300J03 | 2 | | |
| C29 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C30 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F10M | REF | | |

## SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| C31 | Cap, mica, 1000 pf, ±5%, 500V | 148387 | 53021 | D19F102J | REF | | |
| C32, C33 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C34 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C35 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C36 | Cap, cer. 0.0012 uf, ±10 %, 500V | 106732 | 71590 | CF-122 | 2 | | |
| C37, C38 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C39 | Cap, mica, 82 pf, ±5%. 500V | 148502 | 53021 | D15ED820J03 | 2 | | |
| C40, C41 | Cap, mica, 150 pf, ±5%, 500V | 148478 | 53021 | D15FD151J03 | 2 | | |
| C42 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B10F103M | REF | | |
| C43 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C44 | Cap, mica, 1000 pf, ±5%, 500V | 148387 | 53021 | CD19FD102J03 | REF | | |
| C45 | Cap, mica, 33 pf, ±5%, 500V | 160317 | 53021 | CD15ED330J03 | REF | | |
| C46, C47 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C48 | Cap, plstc, 0.027 uf, ±10%, 250V | 267120 | 73445 | C280AE/A27K | 3 | | |
| C49 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C50 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C51 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C52 | Cap, mica, 82 pf, ±5%. 500V | 148502 | 53021 | D15ED820J03 | REF | | |
| C53, C54, C55, C56, C57, C58 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C59 | Cap, mica, 91 pf, ±5%, 500V | 277228 | 53021 | D15FD91J03 | 2 | | |
| C60 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C61 | Cap, mica, 91 pf, ±5%, 500V | 277228 | 53021 | D15FD91J03 | REF | | |
| C62 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |

## SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| C63 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C64 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C65 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023101F103M | REF | | |
| C66 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C67 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C68 | Cap, mica, 1500 pf, ±5%, 500V | 148361 | 53021 | D19FD152J03 | 4 | | |
| C69 | Cap, mica, 200 pf, ±5%, 500V | 272880 | 53021 | D15FD201J03 | 2 | | |
| C70 | Cap, mica, 390 pf, ±5%, 500V | 148437 | 53021 | D15FD391J03 | REF | | |
| C71 | Cap, plstc, 0.015 uf, ±10%, 200V | 182154 | 14655 | DMF2515 | 1 | | |
| C72 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C73 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C74 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C75 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C76 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B10F103M | REF | | |
| C77 | Cap, mica, 1500 pf, ±5%. 500V | 148361 | 53021 | D19FD152J03 | REF | | |
| C78 | Cap, mica, 270 pf, ±5%, 500V | 148452 | 53021 | D15FD271J03 | 2 | | |
| C79 | Cap, mica, 1500 pf, ±5%, 500V | 148361 | 53021 | D19FD152J03 | REF | | |
| C80 | Cap, mica, 200 pf, ±5%, 500V | 272880 | 53021 | D15FD201J03 | REF | | |
| C81 | Cap, mica, 430 pf, ±5%, 500V | 177980 | 14655 | D15FD431J03 | 1 | | |
| C82 | Cap, cer, 0.0012 uf, ±10%, 500V | 106732 | 71590 | CF-122 | REF | | |
| C83 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C84 | Cap, mica, 33 pf, ±5%, 500V | 160317 | 53021 | D15ED330J03 | REF | | |
| C85 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C86 | Cap, ta, 68 uf, ±20%, 15V | 193615 | 56289 | 196D68X0015-LA3 | 3 | | |
| C87 thru C91 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C93 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C94 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |

## SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| C95 thru C98 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C99, C100 | Cap, ta, 68 uf, ±20%, 15V | 193615 | 56289 | 196D686X0015 LA3 | REF | | |
| C101, C102 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C103 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C104 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C105 | Cap, mica, 1500 pf, ±5%, 500V | 148361 | 53021 | D19FD152J03 | REF | | |
| C106 | Cap, mica, 480 pf, ±1%, 500V | 182931 | 53021 | D19ED481F03 | 1 | | |
| C107 | Cap, mica, 1300 pf, ±5%, 500V | 182881 | 53021 | D19FD132J03 | REF | | |
| C108 | Cap, mica, 270 pf, ±5%, 500V | 148452 | 53021 | D15FD221J03 | REF | | |
| C109 | Cap, mica, 220 pf, ±5%, 500V | 170423 | 53021 | D15FD271J03 | 1 | | |
| C110 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C111, C112 | Cap, plstc, 0.02 uf, ±10%, 250V | 267120 | 73445 | C280AE/A27K | REF | | |
| C113 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C114, C115 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C116, C117, C118 | Cap, feed-thru | 248286 | 04222 | BSF-1BB | 3 | | |
| CR1, CR2 | Diode, tuning, matched set | 347534 | 89536 | 347534 | 1 | | |
| CR3, CR4, CR5, CR6 | Diode, si, 150 mA | 203323 | 03508 | 1N4148 | 5 | 2 | |
| CR7, CR10 | Diode, tuning, matched set | 347534 | 89536 | 347534 | 1 | 1 | |
| CR8 | Diode, germanium, 80 mA, 100 piv | 149187 | 93332 | 1N270 | 1 | 1 | |
| CR9 | Diode, si, 150 mA | 203323 | 03508 | 1N4148 | REF | | |

## SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| C63 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C64 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C65 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023101F103M | REF | | |
| C66 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C67 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C68 | Cap, mica, 1500 pf, ±5%, 500V | 148361 | 53021 | D19FD152J03 | 4 | | |
| C69 | Cap, mica, 200 pf, ±5%, 500V | 272880 | 53021 | D15FD201J03 | 2 | | |
| C70 | Cap, mica, 390 pf, ±5%, 500V | 148437 | 53021 | D15FD391J03 | REF | | |
| C71 | Cap, plstc, 0.015 uf, ±10%, 200V | 182154 | 14655 | DMF2515 | 1 | | |
| C72 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C73 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C74 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C75 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |
| C76 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B10F103M | REF | | |
| C77 | Cap, mica, 1500 pf, ±5%. 500V | 148361 | 53021 | D19FD152J03 | REF | | |
| C78 | Cap, mica, 270 pf, ±5%, 500V | 148452 | 53021 | D15FD271J03 | 2 | | |
| C79 | Cap, mica, 1500 pf, ±5%, 500V | 148361 | 53021 | D19FD152J03 | REF | | |
| C80 | Cap, mica, 200 pf, ±5%, 500V | 272880 | 53021 | D15FD201J03 | REF | | |
| C81 | Cap, mica, 430 pf, ±5%, 500V | 177980 | 14655 | D15FD431J03 | 1 | | |
| C82 | Cap, cer, 0.0012 uf, ±10%, 500V | 106732 | 71590 | CF-122 | REF | | |
| C83 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C84 | Cap, mica, 33 pf, ±5%, 500V | 160317 | 53021 | D15ED330J03 | REF | | |
| C85 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C86 | Cap, ta, 68 uf, ±20%, 15V | 193615 | 56289 | 196D68X0015-LA3 | 3 | | |
| C87 thru C91 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C93 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C94 | Cap, ta, 2.2 uf, ±20%, 20V | 161927 | 56289 | 196D225X0020 | REF | | |

## SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| C95 thru C98 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C99, C100 | Cap, ta, 68 uf, ±20%, 15V | 193615 | 56289 | 196D686X0015 L A3 | REF | | |
| C101, C102 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C103 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C104 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C105 | Cap, mica, 1500 pf, ±5%, 500V | 148361 | 53021 | D19FD152J03 | REF | | |
| C106 | Cap, mica, 480 pf, ±1%, 500V | 182931 | 53021 | D19ED481F03 | 1 | | |
| C107 | Cap, mica, 1300 pf, ±5%, 500V | 182881 | 53021 | D19FD132J03 | REF | | |
| C108 | Cap, mica, 270 pf, ±5%, 500V | 148452 | 53021 | D15FD221J03 | REF | | |
| C109 | Cap, mica, 220 pf, ±5%, 500V | 170423 | 53021 | D15FD271J03 | 1 | | |
| C110 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C111, C112 | Cap, plstc, 0.02 uf, ±10%, 250V | 267120 | 73445 | C280AE/A27K | REF | | |
| C113 | Cap, ta, 10 uf, ±20%, 20V | 330662 | 12954 | D10GSB20M | REF | | |
| C114, C115 | Cap, cer, 0.01 uf, ±20%, 50V | 149153 | 56289 | C023B101F103M | REF | | |
| C116, C117, C118 | Cap, feed-thru | 248286 | 04222 | BSF-1BB | 3 | | |
| CR1, CR2 | Diode, tuning, matched set | 347534 | 89536 | 347534 | 1 | | |
| CR3, CR4, CR5, CR6 | Diode, si, 150 mA | 203323 | 03508 | 1N4148 | 5 | 2 | |
| CR7, CR10 | Diode, tuning, matched set | 347534 | 89536 | 347534 | 1 | 1 | |
| CR8 | Diode, germanium, 80 mA, 100 piv | 149187 | 93332 | 1N270 | 1 | 1 | |
| CR9 | Diode, si, 150 mA | 203323 | 03508 | 1N4148 | REF | | |

## SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| CR12 | Diode, tuning, 200 mA | 363812 | 04713 | MV109 | 1 | 1 | |
| J1, J2, J3 | Conn, male, coaxial | 207639 | 13511 | 27-875 | 3 | | |
| L1, L2 | Choke, 6-turn | 320911 | 89536 | 320911 | 20 | | |
| L3, L4, L5 | Inductor, 6800 uh, 62 mA | 363184 | 24759 | MR-6800 | 3 | | |
| L6, L7, L8, L9, L10, L11 | Choke, 6-turn | 320911 | 89536 | 320911 | REF | | |
| L12 | Inductor, 1,000 uh, 140 mA | 147819 | 72259 | WEE1000 | 1 | | |
| L13, L14 | Choke, rf, 22 uh, ±20%, 590 mA | 147843 | 72259 | WEE22 | 3 | | |
| L15, L16 | Choke, 6-turn | 320911 | 89536 | 320911 | REF | | |
| L17 | Inductor, 470 uh, ±5%, 180 mA | 147827 | 72259 | WEE470 | 1 | | |
| L18, L19 | Choke, 6-turn | 320911 | 89536 | 320911 | REF | | |
| L20 | Inductor, 39000 uh, 31 mA | 363200 | 24759 | MR39000 | 1 | | |
| L21 | Inductor, 27000 uh, 34 mA | 363192 | 24759 | MR27000 | 1 | | |
| L22, L23, L24, L25, L26 | Choke, 6-turn | 320911 | 89536 | 320911 | REF | | |
| L27 | Choke, rf, 22 uh, ±20%, 590 mA | 147843 | 72259 | WEE22 | REF | | |
| L28 | Inductor, 100,000 uh, 22 mA | 363226 | 24759 | MR100,000 | 1 | | |
| L29 | Inductor, 82,000 uh, 23 mA | 363218 | 24759 | MR82,000 | 1 | | |
| L30, L31, L32 | Choke, 6-turn | 320911 | 89536 | 320911 | REF | | |
| Q1, Q2 | Xstr, si, PNP | 340471 | 07263 | 2N4917 | 4 | 1 | |

## SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| Q3, Q4, Q5 | Xstr, si, NPN | 248351 | 04713 | MPS918 | 17 | 4 | |
| Q6 | Xstr, si, PNP | 226290 | 04713 | MPS3640 | 12 | 3 | |
| Q7 | Xstr, si, PNP | 229898 | 04713 | MPS6522 | 1 | 1 | |
| Q8 | Xstr, si, PNP | 226290 | 04713 | MPS3640 | REF | | |
| Q9 | Xstr, si, NPN | 248351 | 04713 | MPS918 | REF | | |
| Q10, Q11 | Xstr, si, PNP | 226290 | 04713 | MPS3640 | REF | | |
| Q12, Q13 | Xstr, si, NPN | 248351 | 04713 | MPS918 | REF | | |
| Q14 | Xstr, si, NPN | 218396 | 04713 | 2N3904 | 5 | 1 | |
| Q15, Q16 | Xstr, si, NPN | 248351 | 04713 | MPS918 | REF | | |
| Q17 | Xstr, si, PNP | 226290 | 04713 | MPS3640 | REF | | |
| Q18, Q19 | Xstr, si, NPN | 248351 | 04713 | MPS918 | REF | | |
| Q20 | Xstr, si, NPN | 218396 | 04713 | 2N3904 | REF | | |
| Q21 | Xstr, si, NPN | 218396 | 04713 | 2N3904 | REF | | |
| Q22, Q23 | Xstr, si, NPN | 248351 | 04713 | MPS918 | REF | | |
| Q24, Q25 | Xstr, si, NPN | 218396 | 04713 | 2N3904 | REF | | |
| Q26, Q27 | Xstr, si, NPN | 248351 | 04713 | MPS918 | REF | | |
| Q28 thru Q31 | Xstr, si, PNP | 226290 | 04713 | MPS3640 | REF | | |
| Q32, Q33 | Xstr, si, PNP | 340471 | 07263 | 2N4917 | REF | | |
| Q34, Q35, Q36 | Xstr, si, PNP | 226290 | 04713 | MPS3640 | REF | | |
| Q37, Q38, Q39 | Xstr, si, NPN | 248351 | 04713 | MPS918 | REF | | |
| R1 | Res, comp, 200Ω, ±5%, ¼W | 193482 | 01121 | CB2015 | 51 | | |
| R3 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | 16 | | |
| R4 | Res, comp, 360Ω, ±5%, ¼W | 340844 | 01121 | CB3615 | 5 | | |
| R5 | Res, comp, 270Ω, ±5%, ¼W | 160804 | 01121 | CB2715 | 5 | | |
| R6, R7 | Res, comp, 1.2k, ±5%, ¼W | 190371 | 01121 | CB1225 | 10 | | |

## SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R8 | Res, comp, 3k, ±5%, ¼W | 193508 | 01121 | CB3025 | 5 | | |
| R9 | Res, comp, 270Ω, ±5%, ¼W | 160804 | 01121 | CB2715 | REF | | |
| R10, R11 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R12 | Res, comp, 47k, ±5%, ¼W | 148163 | 01121 | CB4735 | 2 | | |
| R13 | Res, comp, 2.7k, ±5%, ¼W | 170720 | 01121 | CB2725 | 1 | | |
| R14 | Res, comp, 100Ω, ±5%. ¼W | 147962 | 01121 | CB1015 | REF | | |
| R15 | Res, comp, 560k, ±5%, ¼W | 220533 | 01121 | CB5645 | 1 | | |
| R16 | Res, comp, 4.3k, ±5%, ¼W | 193375 | 01121 | CB4325 | 2 | | |
| R17 | Res, comp, 7.5k, ±5%, ¼W | 193326 | 01121 | CB7525 | 4 | | |
| R18 | Res, mtl flm, 3.92k, ±1%, 1/8W | 294801 | 91637 | MFF1-83921F | 1 | | |
| R19 | Res, mtl flm, 3.83k, ±1%, 1/8W | 235143 | 91637 | MFF1-83831 | 1 | | |
| R20 | Res, comp, 62Ω, ±5%, ¼W | 261842 | 01121 | CB6205 | 1 | | |
| R21 | Res, mtl flm, 750Ω, ±1%, ¼W | 312801 | 91637 | MFF1-87500F | 3 | | |
| R22 | Res, mtl flm, 9.09k ±1%, 1/8W | 221663 | 91637 | MFF1-89091F | 1 | | |
| R23 | Res, comp, 1.8k, ±5%, ¼W | 175042 | 01121 | CB1825 | 1 | | |
| R24 | Res, comp, 560Ω, ±5%, ¼W | 147991 | 01121 | CB5615 | 1 | | |
| R25 | Res, comp, 200Ω, ±5%, ¼W | 193482 | 01121 | CB2015 | REF | | |
| R27 | Res, comp, 360Ω, ±5%, ¼W | 340844 | 01121 | CB3615 | REF | | |
| R28 | Res, comp, 51Ω, ±5%, ¼W | 221879 | 01121 | CB5105 | 1 | | |
| R29 | Res, comp, 100Ω, ±5%, ¼W | 340844 | 01121 | CB3615 | REF | | |
| R30,R31 | Res, comp, 1.2k, ±5%, ¼W | 190371 | 01121 | CB1225 | REF | | |
| R32 | Res, comp, 3k, ±5%, ¼W | 193508 | 01121 | CB3025 | REF | | |
| R33 | Res, comp, 270Ω, ±5%, ¼W | 160804 | 01121 | CB2715 | REF | | |
| R34 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R35 | Res, comp, 300Ω, ±5%, ¼W | 348276 | 01121 | CB1015 | REF | | |
| R36 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R37,R38 | Res, comp, 820Ω, ±5%, ¼W | 148015 | 01121 | CB8215 | 5 | | |
| R39 | Res, comp, 10Ω, ±5%, ¼W | 147868 | 01121 | CB1005 | 2 | | |
| R40 | Res, comp, 1k, ±5%, ¼W | 148023 | 01121 | CB1025 | 2 | | |

## SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R41 | Res, comp, 6.2k, ±5%, ¼W | 221911 | 01121 | CB6225 | 4 | | |
| R42 | Res, comp, 15k, ±5%, ¼W | 148114 | 01121 | CB1535 | 2 | | |
| R43 | Res, comp, 22k, ±5%, ¼W | 148130 | 01121 | CB2235 | 1 | | |
| R44 | Res, comp, 680Ω, ±5%, ¼W | 148007 | 01121 | CB6815 | 1 | | |
| R45 | Res, comp, 2M, ±5%, ¼W | 268771 | 01121 | CB2055 | 1 | | |
| R46 | Res, comp, 30k, ±5%, ¼W | 193417 | 01121 | CB3035 | 1 | | |
| R47 | Res, comp, 7.5k, ±5%, ¼W | 193326 | 01121 | CB7525 | REF | | |
| R48 | Res, comp, 10k, ±5%, ¼W | 148106 | 01121 | CB1035 | 2 | | |
| R49 | Res, comp, 9.1k, ±5%, ¼W | 193318 | 01121 | CB9125 | 1 | | |
| R50 | Res, comp, 3.9k, ±5%,¼W | 148064 | 01121 | CB3925 | 2 | | |
| R51 | Res, comp, 12k, ±5%, ¼W | 159731 | 01121 | CB1235 | 1 | | |
| R52 | Res, comp, 1.3k, ±5%, ¼W | 234252 | 01121 | CB1325 | 1 | | |
| R53 | Res, comp, 120k, ±5%, ¼W | 193458 | 01121 | CB1245 | 1 | | |
| R54 | Res, comp, 200Ω, ±5%, ¼W | 193482 | 01121 | CB2015 | REF | | |
| R56, R57 | Res, comp, 1.2k, ±5%, ¼W | 190371 | 01121 | CB1225 | REF | | |
| R58 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R59 | Res, comp, 3k, ±5%, ¼W | 193508 | 01121 | CB3025 | REF | | |
| R60 | Res, comp, 270Ω, ±5%, ¼W | 160804 | 01121 | CB2715 | REF | | |
| R61 | Res, comp, 150Ω, ±5%, ¼W | 147934 | 01121 | CB1515 | 1 | | |
| R62 | Res, comp, 180Ω, ±5%, ¼W | 147942 | 01121 | CB1815 | 2 | | |
| R63 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R64 | Res, comp, 820Ω, ±5%, ¼W | 148015 | 01121 | CB8215 | REF | | |
| R65 | Res, comp, 10Ω, ±5%, ¼W | 147868 | 01121 | CB1005 | REF | | |
| R66 | Res, comp, 1k, ±5%, ¼ W | 148023 | 01121 | CB1025 | REF | | |
| R67 | Res, comp, 6.2k, ±5%, ¼W | 221911 | 01121 | CB6225 | REF | | |
| R68 | Res, comp, 820Ω, ±5%, ¼W | 148015 | 01121 | CB8215 | REF | | |
| R69 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R70 | Res, comp, 6.2k, ±5%, ¼W | 221911 | 01121 | CB6225 | REF | | |

## SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R71 | Res, comp, 15k, ±5%, ¼W | 148114 | 01121 | CB1535 | REF | | |
| R72 | Res, comp, 360Ω, ±5%, ¼W | 340844 | 01121 | CB3615 | REF | | |
| R73 | Res, comp, 750Ω, ±5%, ¼W | 218024 | 01121 | CB7515 | 2 | | |
| R74 | Res, comp, 13k, ±5%, ¼W | 221598 | 01121 | CB1335 | 2 | | |
| R75 | Res, comp, 1M, ±5%, ¼W | 182204 | 01121 | CB1055 | 1 | | |
| R77 | Res, comp, 200Ω, ±5%, ¼W | 193482 | 01121 | CB2015 | REF | | |
| R78 | Res, comp, 270Ω, ±5%, ¼W | 160804 | 01121 | CB2715 | REF | | |
| R79 | Res, comp, 3k, ±5%, ¼W | 193508 | 01121 | CB3025 | REF | | |
| R80, R81 | Res, comp, 1.2k, ±5%, ¼W | 190371 | 01121 | CB1225 | REF | | |
| R82, R83 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R84 | Res, mtl flm, 13k, ±1%, 1/8W | 335539 | 91637 | MFF1-81302F | 1 | | |
| R85 | Res, comp, 3.9k, ±5%, ¼W | 148064 | 01121 | CB3925 | REF | | |
| R86 | Res, comp, 820Ω, ±5%, ¼W | 148015 | 01121 | CB8215 | REF | | |
| R87 | Res, mtl flm, 20k, ±5%, ¼W | 221614 | 01121 | CB2035 | 1 | | |
| R88 | Res, mtl flm, 27k, ±5%, ¼W | 148148 | 01121 | CB2735 | 1 | | |
| R89 | Res, mtl flm, 1.3k, ±1%, 1/8W | 343921 | 91637 | MFF1-81301F | 1 | | |
| R90 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R91 | Res, comp, 360Ω, ±5%, ¼W | 340844 | 01121 | CB3615 | REF | | |
| R92 | Res, mtl flm, 2.67k, ±1%, 1/8W | 289587 | 91637 | MFF1-82671 | 1 | | |
| R93 | Res, comp, 6.2M, ±5%, ¼W | 221960 | 01121 | CB6255 | 1 | | |
| R94 | Res, comp, 6.2k, ±5%, ¼W | 221911 | 01121 | CB6225 | REF | | |
| R95 | Res, comp, 10k, ±5%, ¼W | 148106 | 01121 | CB1035 | REF | | |
| R96 | Res, comp, 7.5k, ±5%, ¼W | 193326 | 01121 | CB7525 | REF | | |
| R97 | Res, comp, 220Ω, ±5%, ¼W | 147959 | 01121 | CB2215 | 1 | | |
| R98 | Res, comp, 180Ω, ±5%, ¼W | 147942 | 01121 | CB1815 | REF | | |
| R99, R100 | Res, comp, 1.2k, ±5%, ¼W | 190371 | 01121 | CB1225 | REF | | |
| R101 | Res, comp, 3k, ±5%, ¼W | 193508 | 01121 | CB3025 | REF | | |

## SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R102, R103 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R104 | Res, comp, 2k, ±5%, ¼W | 202879 | 01121 | CB2025 | 1 | | |
| R106 | Res, comp, 200Ω, ±5%, ¼W | 147926 | 01121 | CB2015 | REF | | |
| R107 | Res, comp, 4.3k, ±5%, ¼W | 193375 | 01121 | CB4325 | REF | | |
| R108 | Res, comp, 4.7k, ±5%, ¼W | 148072 | 01121 | CB4725 | 1 | | |
| R109 | Res, comp, 2.4 M, ±5%, ¼W | 221945 | 01121 | CB2415 | 1 | | |
| R110 | Res, comp, 47k, ±5%, ¼W | 148163 | 01121 | CB4735 | REF | | |
| R111 | Res, comp, 1.6k, ±5%, ¼W | 266197 | 01121 | CB1625 | 1 | | |
| R112 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R113 | Res, comp, 360Ω, ±5%, ¼W | 340844 | 01121 | CB3615 | REF | | |
| R114 | Res, comp, 2.4k, ±5%, ¼W | 193433 | 01121 | CB2425 | 1 | | |
| R115 | Res, comp, 7.5k, ±5%, ¼W | 193326 | 01121 | CB7525 | REF | | |
| R116 | Res, comp, 750Ω, ±5%, ¼W | 218024 | 01121 | CB7515 | REF | | |
| T1, T2, T3, T4 | Inductor, type 10k, 1.4-1.9 uh @7.9 MHz | 345850 | 89536 | 345850 | 4 | | |
| T5 | Inductor, type 10k, .7-1.3 uh @ 7.9 MHz | 339234 | 89536 | 339234 | 1 | | |
| U1 | IC, TTL, triple 3-input posAND gate | 340448 | 01295 | SN74H11N | 7 | 2 | |
| U2 | IC, DTL, SSI, hex inverter | 268367 | 04713 | MC836P | 2 | 1 | |
| U3 | IC, TTL (Schottky)quad 2-input NAND gate | 363580 | 01295 | SN74S00N | 1 | 1 | |
| U4 | IC, DTL, SSI, hex inverter | 268367 | 04713 | MC836P | REF | | |
| U5 | IC,TTL, triple 3-input pos AND gate | 340448 | 01295 | SN74H11N | REF | | |
| U6 | IC, TTL, 50 MHz, decade counter | 320754 | 01295 | SN74196N | 5 | 1 | |
| U7 | IC, DTL, quad 2-input NAND gate | 268375 | 04713 | MC846P | 1 | 1 | |
| U8 | IC, TTL, 50 MHz, decade counter | 320754 | 01295 | SN74196N | REF | | |
| U9 | IC, TTL, JK flip-flop, AND inputs | 293092 | 01295 | SN74H102N | 4 | 1 | |
| U10 | IC, TTL, SSI, dual J-K neg. edge-trig. flip-flop w/preset and clear | 293100 | 01295 | SN74H106N | 4 | 1 | |
| U11 | IC, TTL, JK flip-flop, AND inputs | 293092 | 01295 | SN74H102N | REF | | |

## SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| U12 | IC, TTL, SSI, dual J-K neg. edge-trig. flip-flop w/preset and clear | 293100 | 01295 | SN74H106N | REF | | |
| U13 | IC, operational amplifier | 271502 | 07263 | LM301A | 3 | 1 | |
| U14 | IC, TTL, phase-frequency detector | 320721 | 04713 | MC4044P | 5 | 1 | |
| U15 | IC, TTL, MSI, decade counters | 293159 | 01295 | SN7490N | 3 | 1 | |
| U16 | IC, TTL, quad-2-input NAND gate | 292953 | 01295 | SN7400N | 3 | 1 | |
| U17 | IC, TTL, quad 2-input + NAND gates | 293068 | 01295 | SN74H00P | 2 | 1 | |
| U18 | IC, TTL, triple 3-input pos AND gate | 340448 | 01295 | SN74H11N | REF | | |
| U19 | IC, linear 4-quadrant multiplier, db mix | 363762 | 01295 | SN76514N | 2 | 1 | |
| U21 | IC, TTL, phase–frequency detector | 320721 | 04713 | MC4044P | REF | | |
| U22 | IC, TTL, MSI, decade counters | 293159 | 01295 | SN7490N | REF | | |
| U23 | IC, operational amplifier | 271502 | 07263 | LM301A | REF | | |
| U24 | IC, TTL, 50 MHz, decade counter | 320754 | 01295 | SN74196N | REF | | |
| U25 | IC, TTL, triple 3-input pos AND gate | 340448 | 01295 | SN74H11N | REF | | |
| U26 | IC, linear 4-quadrant multiplier, db mix | 363762 | 01295 | SN76514N | REF | | |
| U28 | IC, TTL, phase-frequency detector | 320721 | 04713 | MC4044P | REF | | |
| U29 | IC , TTL, MSI, decade counters | 293159 | 01295 | SN7490N | REF | | |
| U30 | IC, TTL, triple 3-input pos AND gate | 340448 | 01295 | SN74H11N | REF | | |
| U31 | IC, TTL, quad 2-input + NAND gates | 293068 | 01295 | SN74H00P | REF | | |
| U32, U45 | IC, digital presettable hi-speed decade/ binary counter | 348250 | 18324 | N8290A | 2 | 1 | |
| U33 | IC, TTL, JK flip-flop, AND inputs | 293092 | 01295 | SN74H102N | REF | | |
| U34 | IC, TTL, 50 MHz preset decoded binary counter/latch | 320770 | 01295 | SN74197N | 2 | 1 | |
| U35, U36 | IC, TTL, SSI, dual J-K neg, edge-trig. | 293100 | 01295 | SN74H106N | REF | | |
| U37 | IC, operational amplifier | 271502 | 07263 | LM301A | REF | | |
| U38 | IC, TTL, phase-frequency detector | 320721 | 04713 | MC4044P | REF | | |
| U39 | IC, TTL J-K flip-flop | 296491 | 01295 | SN7472N | 2 | 1 | |
| U40, U41 | IC, TTL, quad 2-input NAND gate | 292953 | 01295 | SN7400N | REF | | |

## SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| U42 | IC, TTL, 35 MHz presettable decade and binary counter | 320747 | 01295 | SN74176N | 1 | 1 | |
| U44 | IC, TTL, triple 3-input pos AND gate | 340448 | 01295 | SN74H11N | REF | | |
| U46 | IC, TTL, 50 MHz, decade counter | 320754 | 01295 | SN74196N | REF | | |
| U47 | IC, TTL, triple 3-input pos AND gate | 340448 | 01295 | SN74H11N | REF | | |
| U48 | IC, TTL, J-K, flip-flop, AND inputs | 293092 | 01295 | SN74H102N | REF | | |
| U49 | IC, TTL, 50 MHz preset decoded binary counter latch | 320770 | 01295 | SN74197N | REF | | |
| U50 | IC, TTL, phase-frequency detector | 320721 | 04713 | MC4044P | REF | | |
| U51 | IC, TTL, J-K flip-flop | 296491 | 01295 | SN7472N | REF | | |
| 2 | Cable, rf | 190322 | 89536 | 190322 | 24 in. | | |
| 3 | Conn, body | 295337 | 35037 | 3402 body | 1 | | |
| 4 | Conn, cover | 295329 | 35037 | 3402 cover | 1 | | |
| 5 | Connector, 34 pin | 325910 | 35037 | 3424 | 1 | | |
| 6 | Cable, flat | 291807 | 35037 | 3350 | 2.17 Ft. | | |
| 7 | Ferrite tube, choke core | 321182 | 02114 | 56-590-65-4B | 1 | | |
| | | 103424 | 12014 | R3647 x 532 | 16 | | |
| | Socket, IC, 14 contact (not illustrated) | 276527 | 23880 | TSA-2900-16W | 5 | | |

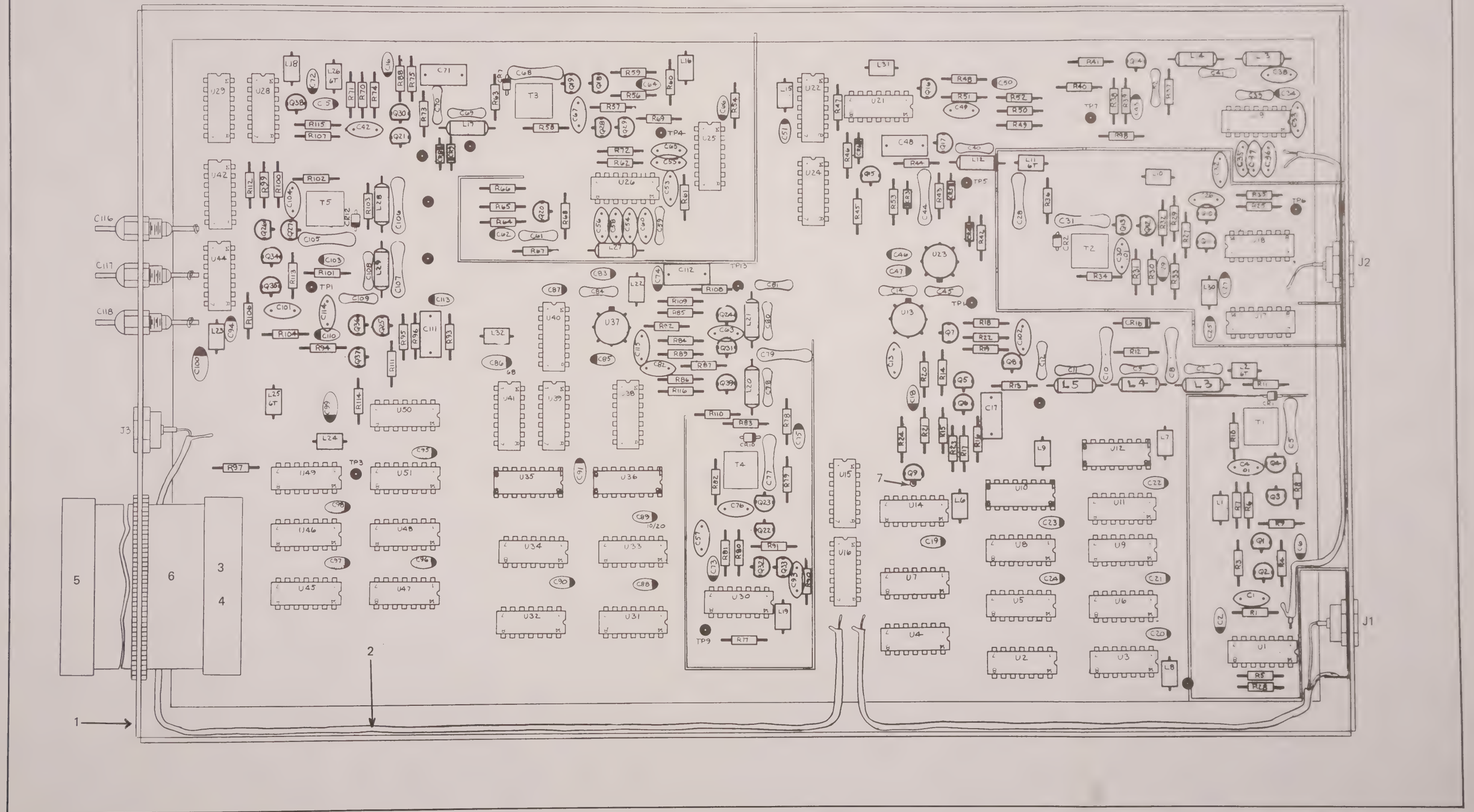


Figure 5-23. SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

## COMPUTER PCB ASSEMBLY, A10

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A10 | COMPUTER PCB ASSEMBLY<br>Figure 5-24 6160B - 4012 | 356287 | 89536 | 356287 | REF | | |
| C1 thru C9, C11 thru C19 | Cap, ta, 2.2 uf, ±2%, 20V | 161927 | 56289 | 196D225X0020 | 18 | | |
| J7 | Conn, cable, body<br>Connector, flat cable, 34 contact<br>Conn, cover<br>(not illustrated) | 295337<br>325910<br>295329 | 35037<br>35037<br>35037 | 3402 BODY<br>3424<br>3402 COVER | 1<br>1<br>1 | | |
| L1 | Choke, rf | 323816 | 89536 | 323816 | 1 | | |
| R1 thru R32 | Res, comp, 6.8k, ±10%, 1/8W | 246967 | 01121 | BB6821 | 32 | | |
| R34 | Res, comp, 100Ω, ¼W | 147926 | 01121 | CB1015 | 1 | | |
| U1 thru U6 | IC, DTL, Hex inverter | 320853 | 04713 | MC835P | 6 | 2 | |
| U7 | IC, DTL, SSI, Hex inverter | 268367 | 04713 | MC836P | 2 | 1 | |
| U8 | IC, DTL, triple 3-input NAND gate | 266312 | 04713 | MC862P -6909 | 1 | 1 | |
| U9 thru U12 | IC, TTL, Data-selector/multiplexer | 320762 | 01295 | SN74151N | 4 | 1 | |
| U13 thru U16 | IC, DTL, gate, quad 2-input NAND | 268375 | 04713 | MC846P | 6 | 2 | |
| U17, U18, U19 | IC, TTL, BCD-to-Binary/Binary to BCD | 320697 | 04713 | MC4001P | 5 | 1 | |
| U20 | IC, TTL, 4-bit binary counter | 320739 | 01295 | SN7493N | 1 | 1 | |
| U21 | IC, TTL, BCD to decimal decoders | 293142 | 01295 | SN7442N | 1 | 1 | |
| U22 | IC, TTL, MSI, dual 4-bit latch | 293191 | 04713 | MC8308P | 5 | 1 | |
| U23 | IC, TTL, BCD to decimal decoder | 293142 | 01295 | SN7442N | 1 | 1 | |
| U25 | IC, DTL, SSI, Hex inverter | 268367 | 04713 | MC836P | REF | | |

## COMPUTER PCB ASSEMBLY, A10

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| U28 thru U31 | IC, TTL, MSI, dual 4-bit latch | 293191 | 04713 | MC8308P | REF | | |
| U32, U33 | IC, DTL, gate, quad 2-input NAND | 268375 | 04713 | MC846P | REF | | |
| U34 | IC, TTL, dual D-type edge trig. | 310227 | 01295 | SN7474N | 1 | 1 | |
| U35 | IC, TTL, quad, 2-input NAND gate | 292953 | 01295 | SN7400N | 1 | 1 | |
| U36, U37 | IC, TTL, BCD-to-Binary/Binary to BCD | 320697 | 04713 | MC4001P | REF | | |
| | Bracket hinge | 346213 | 89536 | 346213 | 1 | | |
| | Cable Assy, #11, 12 (Not illustrated) | 270280 | 89536 | 270280 | 1 | | |
| | Cable, clamp (Not illustrated) | 172080 | 06383 | SST-1 | 1 | | |
| | Cable, flat (Not illustrated) | 291807 | 35037 | 3350 | .84' | | |
| | Conn, post (Not illustrated) | 267500 | 00779 | 86144-2 | 102 | | |
| | Rivet (Not illustrated) | 103424 | 12014 | R3647X5 - 32 | 3 | | |
| | Socket, IC (Not illustrated) | 276535 | 23880 | TSA290016W | 1 | | |

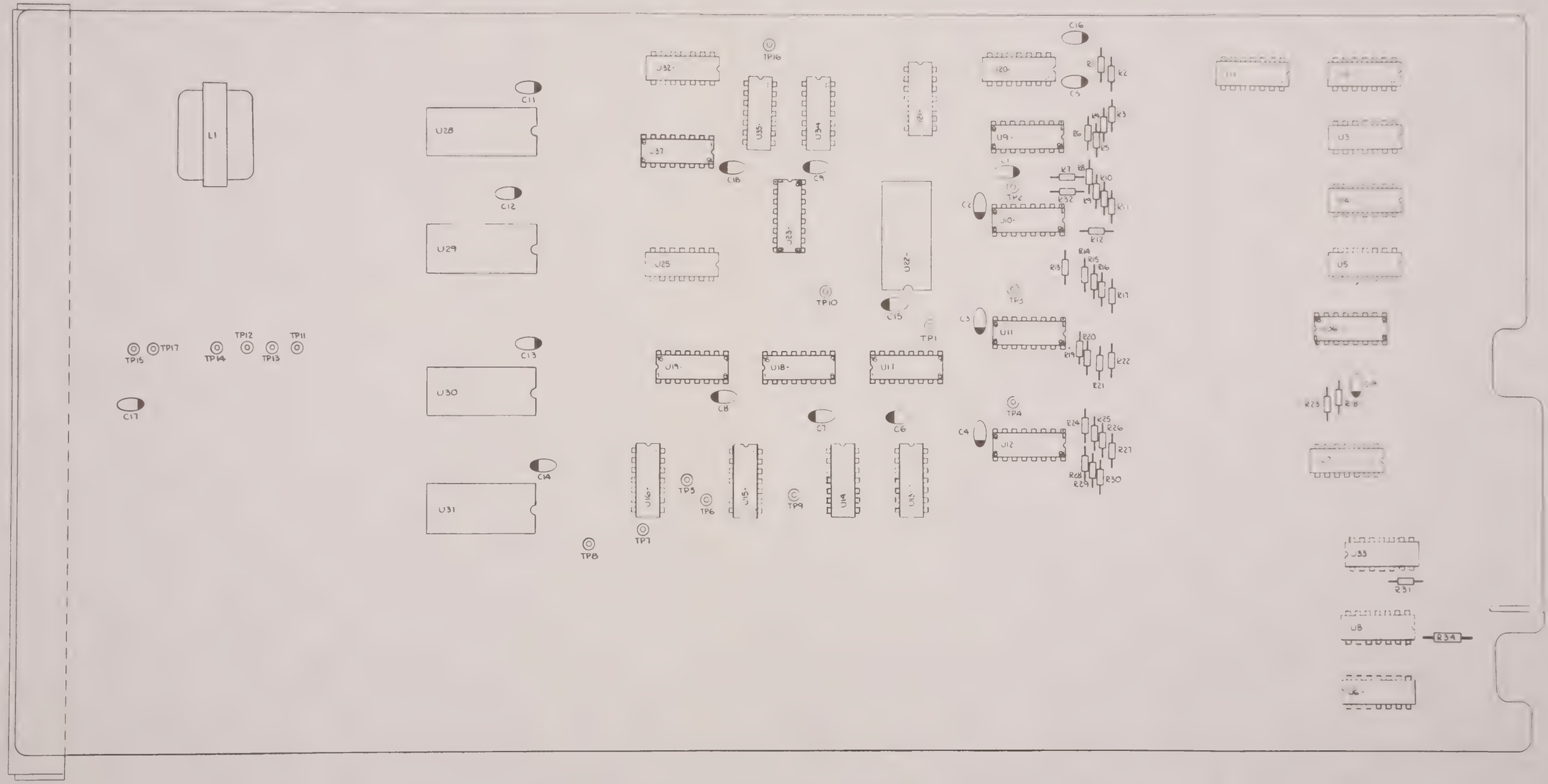


Figure 5-24. COMPUTER PCB ASSEMBLY, A10

## OUTPUT DIVIDER MODULE ASSEMBLY, A11

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A11 | **OUTPUT DIVIDER MODULE ASSEMBLY 6160A-4111 Figure 5-25** | 323758 | 89536 | 323758 | REF | | |
| A11A1 | Output Divider PCB Assembly 6160A-4011 | | | | 1 | | |
| 1 | Module Cover, inner | 323238 | 89536 | 323238 | 1 | | |
| 2 | Module cover, outer | 323246 | 89536 | 323246 | 1 | | |
| 3 | Screw, 4 - 40 x ¼ PNH - Phillips | 129890 | 73734 | 19022 | 5 | | |
| 4 | Spacer, Hex 4 - 40 x 5/16, Threaded | 275503 | 73734 | 111410 | 2 | | |
| 5 | Washer, flat #4 | 110775 | 73734 | 1442 | 2 | | |
| 6 | Bracket, Module mounting | 324590 | 89536 | 324590 | 1 | | |
| 7 | Screw, 4 - 40 x 3/8 PNH - Phillips | 152124 | 73734 | 19024 | 2 | | |
| 8 | Clamp, cable | 100826 | 95987 | ¼ - 6B | 1 | | |
| 9 | Washer, Flat, #4 S. S. | 146225 | 86928 | ST10-18-10 | 1 | | |

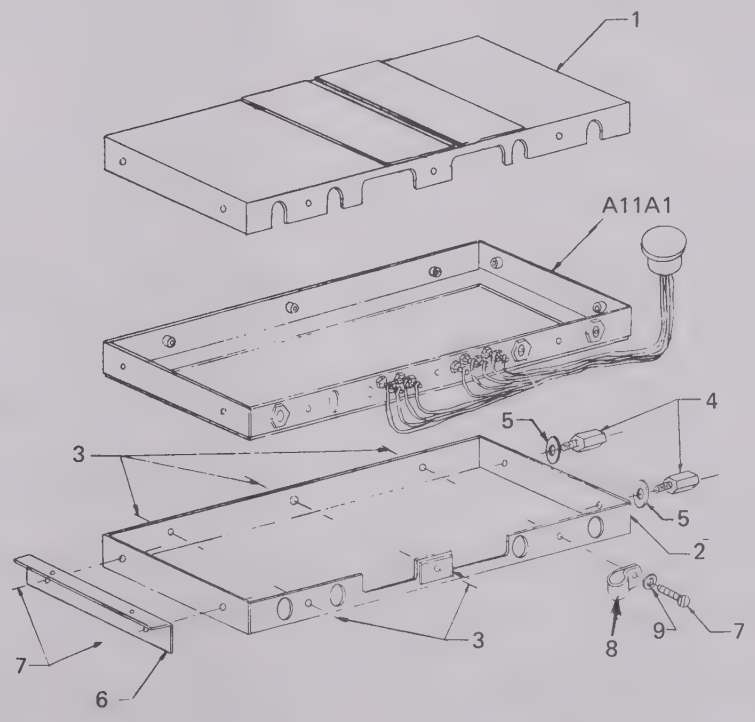


Figure 5-24. OUTPUT DIVIDER MODULE ASSEMBLY, A11

## OUTPUT DIVIDER PCB ASSEMBLY, A11A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A11A1 | OUTPUT DIVIDER PCB ASSEMBLY<br>Figure 5-26 6160A-4011 | | | | REF | | |
| C1 thru C5, C12, C13, C14, C19, C21, C22, C45, C67, C80, C94, C95, C107, C108, C124 | Cap, cer, 0.0012 uf ±10%, 500V | 106732 | 71590 | CF122 | 19 | | |
| C10, C84, C85 | Cap, Ta, 0.22 uf ±20%, 35V | 161331 | 56289 | 196D224X0035 | 3 | | |
| C15, C24, C31, C32, C37, C38, C44, C49, C50, C55, C56, C72, C76, C81, C93, | Cap, cer, 0.05 uf ±80/-20%, 25V | 148942 | 72982 | 5855-Y5U-5032 | 28 | | |

## OUTPUT DIVIDER PCB ASSEMBLY, A11A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| Cont. C96, C97, C101 thru C106, C116 thru C120 | Cap, cer, 0.05 uf ±80/-20%, 25V | 148942 | 72982 | 5855-Y5U-5032 | REF | | |
| C16, C17, C43, C89 | Cap, mica, 22 pf ±5%, 500V | 148551 | 53021 | D15E220J | 4 | | |
| C18 | Cap, mica, 39 pf ±5%, 500V | 148544 | 53021 | D15E390J | 1 | | |
| C20 C30 | Cap, mica, 33 pf ±5%, 500V | 160317 | 53021 | D15E330J | 2 | | |
| C25, C26, C47 | Cap, mica, 390 pf ±5%, 500V | 148437 | 53021 | D15F391J | 3 | | |
| C27 | Cap, mica, 82 pf ±5%, 500V | 148502 | 53021 | D15E820J | 1 | | |
| C28, C33, C39, C51, C57, C63 | Cap, cer, .01 uf, ±20%, 100V | 149153 | 56289 | C023B101F 103M | 6 | | |
| C29 | Cap, mica, 56 pf ±5%, 500V | 148528 | 53021 | D15F560J | 1 | | |
| C34, C42 | Cap, mica, 180 pf ±5%, 500V | 148460 | 53021 | D15F181J | 2 | | |
| C35, C111 | Cap, mica, 47 pf ±5%, 500V | 148536 | 53021 | D15E470J | 2 | | |
| C36 | Cap, mica, 130 pf ±5%, 500V | 266205 | 53021 | D15F131J | 1 | | |
| C40, C48 | Cap, mica, 360 pf ±5%, 500V | 325878 | 53021 | D15F361J | 2 | | |
| C41 | Cap, mica, 110 pf ±1%, 500V | 170415 | 53021 | D15F111F | 1 | | |
| C46 | Cap, mica, 510 pf ±5%, 500V | 148411 | 53021 | D15E511J | 1 | | |

## OUTPUT DIVIDER PCB ASSEMBLY, A11A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| C52 | Cap, mica, 1000 pf ±5%, 500V | 148387 | 53021 | D19F102J | 1 | | |
| C53 | Cap, mica, 270 pf ±5%. 500V | 148452 | 53021 | D15F271J | 1 | | |
| C54, C109 | Cap, mica, 470 pf ±5%,500V | 148429 | 53021 | D19F471 | 2 | | |
| C58 | Cap, mica, 2000 pf ±5%, 500V | 321158 | 53021 | D19F202J | 1 | | |
| C59 | Cap, mica, 560 pf ±5%, 500V | 170431 | 53021 | D19F561J | 1 | | |
| C60 | Cap, mica, 820 pf ±5%, 500V | 148395 | 53021 | D19F82DJ | 1 | | |
| C61, C62, C73, C82, C83, C86, C92, C100, C114 | Cap, plstc, 0.1 uf ±10%, 250V | 161992 | 73445 | C280AE100K | 9 | | |
| C64 | Cap, mica, 3900 pf ±5%, 500V | 160325 | 53021 | D19F 392J | 1 | | |
| C65 | Cap, mica, 1075 pf ±1%, 500V | 182899 | 53021 | D19F1075F | 1 | | |
| C66 | Cap, mica, 1800 pf ±5%, 500V | 148353 | 53021 | D19F182J | 1 | | |
| C68, C69, C71, C75, C78 | Cap, Ta, 2.2 uf ±20%, 20V | 161927 | 56289 | 196D225 X0020 | 5 | | |
| C70 C74, C79 | Cap, Ta, 10 uf ±20%, 10V | 176214 | 56289 | 196D 106 X001 | 3 | | |
| C77 | Cap, mica, 18 pf ±5%, 500V | 266585 | 53021 | D15C180J | 1 | | |
| C87 | Cap, mica, 2 pf ±0.5, 500V | 175208 | 53021 | D15C020D | 1 | | |
| C88 | Cap, var, 1.7 to 010 pf +70/-20%, 250V | 321109 | 73899 | DVJ300A | 1 | | |
| C90, C113 | Cap, cer, 6.8 pf ±0.25 pf, 250V | 272518 | 72982 | 301000C0H 0689C | 2 | | |
| C91 | Cap, mica, 15 pf ±5%, 500V | 148569 | 53021 | D15C150J | 1 | | |
| C110 | Cap, mica, 120 pf, ±5%, 500V | 148486 | 53021 | D15F121J | 1 | | |

## OUTPUT DIVIDER PCB ASSEMBLY, A11A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| C112 | Cap, mica, 10 pf, ±5%, 500V | 175216 | 53021 | D15C100K | 1 | | |
| C115 | Cap, plstc, 1.0 uf, ±10%, 250V | 190330 | 73445 | C280AE/AM | 1 | | |
| C121 | Cap, elect, 10 uf +50/-10%, 25V | 170266 | 73445 | C426ARF10 | 1 | 1 | |
| C122 | Cap, Ta, 39 uf ±20%, 6V | 163915 | 56289 | 196D396X0006 | 1 | | |
| C123 thru C131 | Cap, feed thru | 248286 | 04222 | BSF-1BB | 9 | | |
| CR1 thru CR6 | Diode, germanium, 80 mA, 100 piv | 149187 | 93332 | 1N270 | 6 | 2 | |
| CR7, CR13 | Diode, pin, silicon | 321216 | 28480 | 5082-3080 | 2 | 1 | |
| CR8, CR9 | Diode, silicon, 150 mA | 203323 | 03508 | 1N4148 | 2 | 1 | |
| CR10 | Diode, zener, 20 mA | 159798 | 04713 | 2N 3906 | 1 | 1 | |
| CR11, CR12, CR15, CR16 | Diode, hot carrier | 313247 | 28480 | 5082-2811 | 4 | 1 | |
| CR14 | Diode, silicon, 75V | 234450 | 07910 | CD9049 | 1 | 1 | |
| CR17, CR19 | Diode, silicon, 150 mA | 234468 | 07910 | CD9039 | 2 | 1 | |
| CR18 | Diode, germanium, 50 mA | 233197 | 14433 | G1041 | 1 | 1 | |
| J1,J2, J4 | Conn, male, coaxial | 207639 | 13511 | 27875 | 3 | | |
| L1,L24 | Choke, 0.1 uh ±20% | 249110 | 72259 | WEE-0-10 | 2 | | |
| L2,L4 | Inductor, 0.12 uh ±20%, 3350 mA | 256289 | 72259 | WEE-0.12 | 2 | | |
| L3 | Inductor, 0.1 uh ±10%, 3000 mA | 257154 | 24759 | MR0.10 | 1 | | |
| L5 | Inductor, 0.15 uh ±10%, 2600 mA | 256297 | 24759 | MR 0.15 | 1 | | |
| L6,L18, L20, L29 | Inductor, 0.12 uh ±10%, 2860 mA | 272617 | 24759 | MR-0.12 | 4 | | |
| L7 | Inductor, 0.39 uh ±20%, 1420 mA | 321026 | 72259 | WEE-.39 | 1 | | |
| L8 | Inductor, 0.27 uh ±20%, 2000 mA | 321018 | 72259 | WEE.27 | 1 | | |

## OUTPUT DIVIDER PCB ASSEMBLY, A11A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| L9 | Inductor, 0.47 uh ±20%, 1400 mA | 248047 | 72259 | WEE-0.47 | 1 | | |
| L10 | Inductor, 0.33 uh ±20%, 1900 mA | 207605 | 72259 | WEE-0.33 | 1 | | |
| L11 | Inductor, 0.82 uh ±10%, 725 mA | 320945 | 24759 | MR - 0.82 | 1 | | |
| L12 | Inductor, 0.68 uh ±10%, 790 mA | 320937 | 24759 | MR - 0.68 | 1 | | |
| L13 | Inductor, 1.5 uh ±10%, 1420 mA | 321034 | 72259 | WEE -1.5 | 1 | | |
| L14 | Inductor, 1.2 uh ±10%, 2200 mA | 245498 | 72259 | WEE- 1.2 | 1 | | |
| L15 | Inductor, 3.3 uh ±10%, 2030 mA | 174714 | 72259 | WEE-3-3 | 1 | | |
| L16 | Inductor, 2.2 uh ±10%, 1300 mA | 207571 | 72259 | WEE-2.2 | 1 | | |
| L17, L19, L21, L22, L23, L30, L33, L34 | Bead, 6 turn | 320911 | 89536 | 320911 | 8 | | |
| L35 | Inductor, 2.7 uh ±10%, 1130 mA | 320978 | 27459 | MR-2.7 | 1 | | |
| L36 | Bead, ferrite | 219535 | 02114 | 56-060-85-3B | 1 | | |
| Q1,Q5, Q7,Q9, Q11, Q13, Q15, Q16, 919 Q21, Q23, Q33 | Tstr, silicon, NPN | 248351 | 04713 | MPS918 | 12 | 4 | |
| Q2, Q24, Q29, Q32 | Tstr, silicon, NPN | 272930 | 04713 | 2N5943 | 4 | 1 | |
| | Transipad | 152207 | 07047 Ross | 10123-DAP | 10 | 2 | |

## OUTPUT DIVIDER PCB ASSEMBLY, A11A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| Q3, Q6, Q8, Q10, Q12, Q14, Q17, Q18, Q20, Q22 | Tstr, silicon, PNP | 226290 | 04713 | MPS3640 | 10 | 2 | |
| Q25 | Tstr, silicon, PNP | 229898 | 04713 | MPS6522 | 1 | 1 | |
| Q26 | Tstr, silicon, NPN | 218396 | 04713 | 2N3904 | 1 | 1 | |
| Q27 | Tstr, silicon, PNP | 225599 | 07263 | S22650 | 1 | 1 | |
| Q28 | Tstr, silicon, PNP, dual | 242016 | 11726 | QD401-78E | 1 | 1 | |
| Q30, Q31, Q34 | Tstr, silicon, PNP | 215897 | 04713 | 2N4126 | 3 | 1 | |
| R1 Thru R5 R15, R74, R77, R109 | Res, comp, 51Ω ±5%, ¼W | 221879 | 01121 | CB5105 | 9 | | |
| R6, R106 | Res, comp, 22k ±5%, ¼W | 148130 | 01121 | CB2235 | 2 | | |
| R7, R93 | Res, comp, 47k ±5%, ¼W | 148163 | 01121 | CB4735 | 2 | | |
| R12, R13, R59, R78, R80, R89 | Res, comp, 15Ω ±5%, ¼W | 147876 | 01121 | CB1505 | 6 | | |

## OUTPUT DIVIDER PCB ASSEMBLY, A11A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R14 | Res, comp, 390Ω ±5%, ½W | 109082 | 01121 | EB3915 | 1 | | |
| R16 | Res, met flm, 3.65k ±1%, 1/8W | 293779 | 91637 | MFF1-83-653F | 1 | | |
| R17 | Res, met flm, 1k ±1%, 1/8W | 168229 | 91637 | MFF1-81001F | 1 | | |
| R18, R19, R103 | Res, comp, 22Ω ±5%, ¼W | 147884 | 01121 | CB2205 | 3 | | |
| R20, R83 | Res, comp, 6.8k ±5%, ¼W | 148098 | 01121 | CB6825 | 2 | | |
| R21, R96 | Res, comp, 180Ω ±5%, ¼W | 147942 | 01121 | CB1815 | 2 | | |
| R23 thru R28, R30, R31, R32, R54 | Res, comp, 5.6Ω ±5%, ¼W | 208033 | 01121 | CB5605 | 10 | | |
| R33, R48, R51 | Res, comp, 8.2k ±5%, ¼W | 160796 | 01121 | CB8225 | 3 | | |
| R34, R36, R38 thru R44, R49, R50, R52, R53, R55, R56, R65, R108 | Res, comp, 470Ω ±5%, ¼W | 147983 | 01121 | CB4715 | 17 | | |
| R35, R37, R47 | Res, comp, 270Ω ±5%, ¼W | 160804 | 01121 | CB2715 | 3 | | |

## OUTPUT DIVIDER PCB ASSEMBLY, A11A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R57 | Res, comp, 68Ω ±5%, ¼W | 147918 | 01121 | CB6805 | 1 | | |
| R58, R69, R90, R94, R113 | Res, comp, 200Ω ±5%, ¼W | 193482 | 01121 | CB2015 | 5 | | |
| R60 | Res, comp, 110Ω ±5%‘ ½W | 321166 | 01121 | CB1115 | 1 | | |
| R61 | Res, comp, 100Ω ±5%, ¼W | 147926 | 01121 | CB1015 | 1 | | |
| R62, R104 | Res, comp, 3.9k ±5%, ¼W | 148064 | 01121 | CB3925 | 2 | | |
| R63 | Res, comp, 390Ω ±5%, ¼W | 147975 | 01121 | CB3915 | 1 | | |
| R65, R67, R70, R84, R110 | Res, comp, 2.2k ±5%, ¼W | 148049 | 01121 | CB2225 | 5 | | |
| R66 | Res, comp, 33Ω ±5%, ¼W | 175034 | 01121 | CB3305 | 1 | | |
| R68, R79 | Res, comp, 1.8k ±5%, ¼W | 175042 | 01121 | CB1825 | 2 | | |
| R71 | Res, comp, 6.2k ±5%, ¼W | 221911 | 01121 | CB6225 | 1 | | |
| R72, R85 | Res, comp, 3.3k ±5%, ¼W | 148056 | 01121 | CB3325 | 2 | | |
| R73 | Res, comp, 100Ω ±5%, ½W | 188508 | 01121 | EB1015 | 1 | | |
| R75 | Res, comp, 5.1k ±5%, ¼W | 193342 | 01121 | CB5125 | 1 | | |
| R76 R91 | Res, comp, 24k ±5%, ¼W | 193433 | 01121 | CB2435 | 2 | | |
| R82 R98, R105, R107 | Res, comp, 330Ω ±5%, ¼W | 147967 | 01121 | CB3315 | 4 | | |
| R86 | Res, comp, 82Ω ±5%, ½W | 108746 | 01121 | EB8205 | 1 | | |

## OUTPUT DIVIDER PCB ASSEMBLY, A11A1

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R87 | Res, comp, 27Ω ±5%, ¼W | 160812 | 01121 | CB2705 | 1 | | |
| R88, R112 | Res, comp, 39Ω ±5%, ¼W | 193391 | 01121 | CB3905 | 2 | | |
| R92 | Res, comp, 3.3Ω ±5%, ¼W | 182279 | 01121 | CB3305 | 1 | | |
| R95 | Res, comp, 56Ω ±5%, ¼W | 147900 | 01121 | CB5605 | 1 | | |
| R101 | Res, comp, 15k ±5%, ¼W | 148114 | 01121 | CB1535 | 1 | | |
| R111 | Res, comp, 1k ±5%, ¼W | 148023 | 01121 | CB1025 | 1 | | |
| T3,T4 | Transformer | 253278 | 89536 | 253278 | 2 | | |
| T5 | Transformer | 324400 | 89536 | 324400 | 1 | | |
| T6,T7 | Transformer | 324418 | 89536 | 324418 | 2 | | |
| T8 | Transformer | 324426 | 89536 | 324426 | 1 | | |
| U1,U2 U9 | IC, DTL, Quad 2-Input NAND Gate | 268375 | 01295 | SN15846N | 3 | 1 | |
| U4 | IC, ECL, 85 MHz AC coupled j-k flip-flop | 320820 | 04713 | MC1032P | 1 | 1 | |
| U5,U6 | IC, selected | 334771 | 89536 | 334771 | 2 | | |
| U7 | IC, ECL, dual 3-4 input | 320671 | 04713 | MC1026P | 1 | 1 | |
| U8 | IC, ECL, D-type, flip-flop | 320838 | 04713 | MC1034P | 1 | 1 | |
| U10 | IC, selected | 334060 | 89536 | 334060 | 1 | | |
| XU4, XU5, XU6, XU10 | IC, Socket | 276535 | 23880 | TSA-2900-16W | 4 | | |
| 1 | Harness, Output Divider | 332742 | 89536 | 332742 | 1 | | |

## OUTPUT DIVIDER PCB ASSEMBLY, A11A1

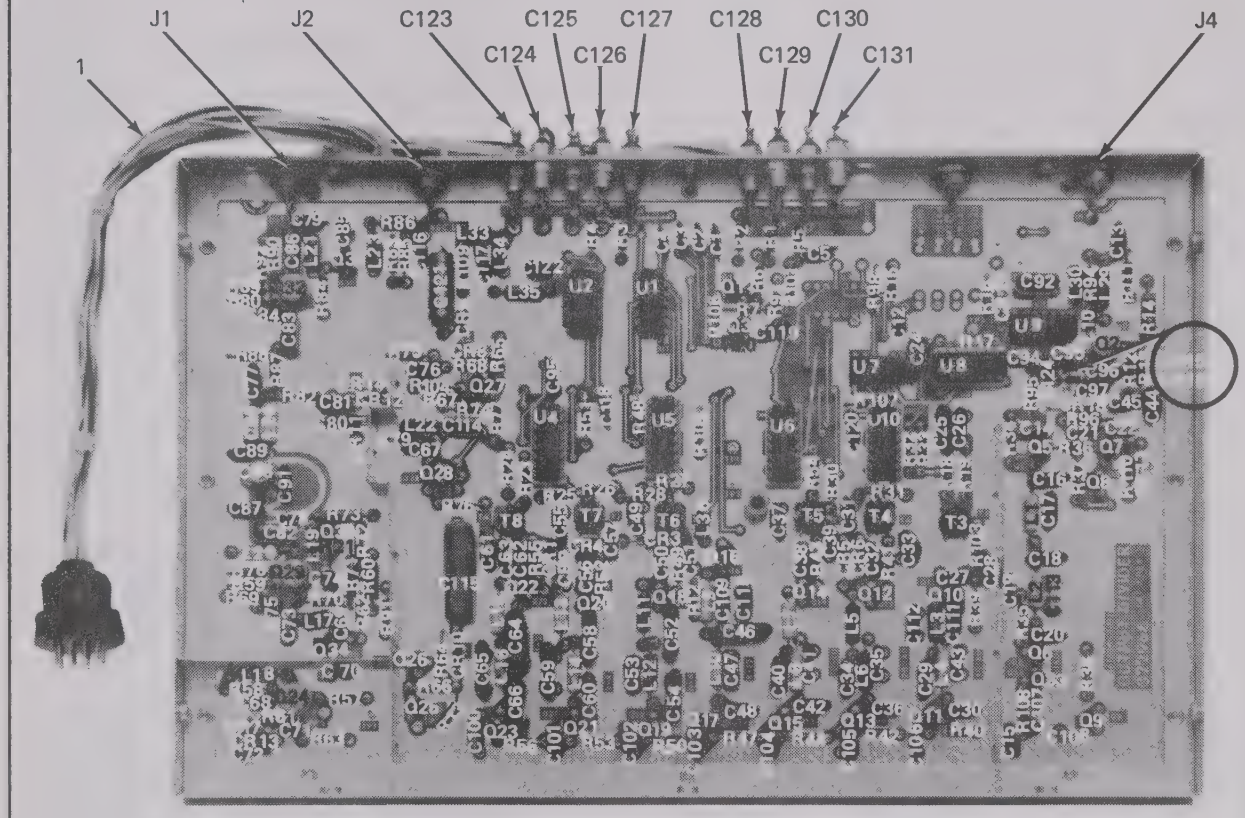


Figure 5-26. OUTPUT DIVIDER PCB ASSEMBLY, A11A1

## POWER SUPPLY PCB ASSEMBLY, A12

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A12 | **POWER SUPPLY PCB ASSEMBLY** **Figure 5-27 6160A-4014** | 322933 | 89536 | 322933 | REF | | |
| C1 | Cap, cer, 0.05 uf +80/-20%, 25V | 148924 | 72982 | 5855-Y5U-503Z | 3 | | |
| C2 | Cap, electlt, 400 uf +50/-10%, 6.3V | 187773 | 73445 | ET471X6P3A6 | 2 | 1 | |
| C3, C4 | Cap, plstc, 0.1 uf, ±10%, 250V | 161992 | 73445 | C280AE/A100K | 6 | | |
| C5, C6, C7 | Cap, tant, 68 uf, ±10%, 15V | 182824 | 56289 | 150D686X9015R2 | 9 | | |
| C8 | Cap, plstc, 2.2 uf, ±10%, 100V | 306522 | 73445 | C280MCH/A2M12 | 2 | | |
| C9 | Cap, mica, 100 pf, ±5%, 500V | 148494 | 53021 | D15F101J | 3 | | |
| C10 | Cap, cer, 0.05 uf, +80/-20%, 25V | 148924 | 72982 | 5855-Y5U-503Z | REF | | |
| C11 | Cap, elctlt, 400 uf, +50/-10%, 6.3V | 187773 | 73445 | ET471X6P3A6 | REF | | |
| C12 | Cap, mica, 100 pf, ±5%, 500V | 148494 | 53021 | D15F101J | REF | | |
| C13, C14 | Cap, plstc, 0.1 uf, ±10%, 250V | 161992 | 73445 | C280AE/A100K | REF | | |
| C15, C16, C17 | Cap, tant, 68 uf, ±10%, 15V | 182824 | 56289 | 150D686X90-15R2 | REF | | |
| C18 | Cap, plstc, 2.2 uf, ±10%, 100V | 306522 | 73445 | C280MCH/A2-M12 | REF | | |
| C19 | Cap, cer, 0.05 uf, +80/-20%, 25V | 148924 | 72982 | 5855-Y5U-503Z | REF | | |
| C20 | Cap, mica 100 pf, ±5%, 500V | 148494 | 53021 | D15F101J | REF | | |
| C21, C22 | Cap, plstc, 0.1 uf, ±10%, 250V | 161992 | 73445 | C280AE/A-100K | REF | | |
| C23, C24, C25 | Cap, tant, 68 uf, ±10%, 15V | 182824 | 56289 | 150D686X9015R2 | REF | | |
| C26 | Cap, tant, 68 uf, ±20%, 15V | 193615 | 56289 | 196D686X00115LA3 | 1 | | |
| CR1 | Diode, zener, ±2%, 6.2V | 325803 | 15818 | TD333408 | 3 | 1 | |

## POWER SUPPLY PCB ASSEMBLY, A12

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| CR2 | Diode, zener, ±5%, 6.2V | 325811 | 07910 | 1N753A | 6 | 2 | |
| CR3, CR4, CR6, CR7, CR8 | Diode, si, 150 mA | 203323 | 03508 | 1N4148 | 12 | 3 | |
| CR5 | Diode, zener, ±10%, 15V | 246033 | 07910 | 1N965A | 1 | 1 | |
| CR9 | Diode, zener, ±5%, 6.2V | 325811 | 07910 | 1N753A | REF | | |
| CR10 | Diode, zener, ±5%, 18V | 327973 | 07910 | 1N967B | 1 | 1 | |
| CR11 | Diode, zener, ±2%, 6.2V | 325803 | 15818 | TD333408 | REF | | |
| CR12 | Diode, zener, ±5%, 6.2V | 325811 | 07910 | 1N753A | REF | | |
| CR13, CR14 | Diode, si, 150 mA | 203323 | 03508 | 1N414B | REF | | |
| CR15 | Diode, zener, ±5%, 13V | 110726 | 07910 | 1N964B | 1 | 1 | |
| CR16, CR17, CR18 | Diode, si, 150mA | 203323 | 03508 | 1N414B | REF | | |
| CR19 | Diode, zener, ±5%, 6.2V | 325811 | 07910 | 1N753A | REF | | |
| CR20 | Diode, zener, ±5%, 15V | 266601 | 07910 | 1N965B | 1 | 1 | |
| CR21 | See R38, R39 | ------ | ----- | ------- | - | - | |
| CR22 | Diode, zener, ±2%, 6.2V | 325803 | 15818 | TD333408 | REF | | |
| CR23 | Diode, zener, ±5%, 6.2V | 325811 | 07910 | 1N753A | REF | | |
| CR24 | Diode, si, 150 mA | 203323 | 03508 | 1N4148 | REF | | |
| CR25 | Diode, zener, ±5%, 6V | 325795 | 15818 | TD333407 | 1 | 1 | |
| CR26 | Diode, zener, ±2%, 5.6V | 325787 | 15818 | TD333406 | 1 | 1 | |
| CR28 | Diode, zener, ±2%. 6.8V | 325845 | 04713 | 5M6.8ZS2 | 1 | 1 | |
| CR29 | Diode, zener, ±5%, 6.2V | 325811 | 07910 | 1N753A | REF | | |
| F1 | Fuse, fast acting, 4 amp | 216846 | 71400 | AGC4A250V | 1 | 5 | |
| L1, L2 | Inductor, 15 mh | 182964 | 72259 | WEE-15,000 | 2 | | |

## POWER SUPPLY PCB ASSEMBLY, A12

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| Q1, Q2, Q3, Q5, Q9, Q11, Q12, Q13 | Xstr, si, PNP | 195974 | 04713 | 2N3906 | 8 | 2 | |
| Q4, Q6, Q7, Q8, Q10, Q14, Q15 | Xstr, si, NPN | 218396 | 04713 | 2N3904 | 7 | 2 | |
| R1 | Res, comp, 1.8K, ±5%, ½W | 109140 | 01121 | EB1825 | 5 | | |
| R2 | Res, mtl flm, 1.43K, ±1%, 1/8W | 325662 | 91637 | MFF1-81431F | 3 | | |
| R3 | Res, mtl flm, 261Ω, ±1%, 1/8W | 328013 | 91637 | MFF1-82610F | 1 | | |
| R4 | Res, fxd WW, 1Ω, ±1%, 150V, 2W | 229534 | 91637 | RS2C70GF | 2 | | |
| R5 | Res, mtl flm, 1.10K, ±1%, 1/8W | 241497 | 91637 | MFF1-81101F | 3 | | |
| R6 | Res, comp, 1.8K, ±5%, ½W | 109140 | 01121 | EB1825 | REF | | |
| R7 | Res, comp, 130Ω, ±5%, ¼W | 325704 | 01121 | CB1315 | 3 | | |
| R8 | Res, comp, 3.3K, ±5%, ½W | 165761 | 01121 | EB3325 | 2 | | |
| R9 | Res, comp, 1K, ±5%, ½W | 108597 | 01121 | EB1025 | 1 | | |
| R10 | Res, comp, 4.7K, ±5%, ¼W | 148072 | 01121 | CB4725 | 1 | | |
| R11 | Res, comp, 51Ω, ±5%, ¼W | 221879 | 01121 | CB5105 | 3 | | |
| R12 | Res, comp, 12K, ±5%, ¼W | 159731 | 01121 | CB1235 | 2 | | |
| R13 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | 2 | | |
| R14 | Res, fxd, WW, 0.15Ω, ±10%, 2W | 325712 | 81483 | BWHR15K | 2 | | |
| R15 | Res, mtl flm, 6.49K, ±1%, 1/8W | 294900 | 91637 | MFF1-86491F | 1 | | |
| R16 | Res, comp, 820Ω, ±5%, ¼W | 148015 | 01121 | CB8215 | 3 | | |
| R17 | Res, comp, 3Ω, ±5%, ¼W | 218040 | 01121 | CB30G5 | 3 | | |
| R18, R19 | Res, dual, WW, 11.85K X 14K, 1W (2 on 1) | 325183 | 89536 | 325183 | 1 | | |

## POWER SUPPLY PCB ASSEMBLY, A12

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R20 | Res, mtl flm, 100Ω, ±1%, 1/8W | 168195 | 91637 | MFF1-81000F | 1 | | |
| R21 | Res, var, CERMET, 100Ω, ±10%, ½W | 285130 | 71450 | 360S-101A | 1 | | |
| R22 | Res, comp, 1.8K, ±5%, ½W | 109140 | 01121 | EB1825 | REF | | |
| R23 | Res, metl flm, 1.43K, ±1%, 1/8W | 325662 | 91637 | MFF1-81431F | REF | | |
| R24 | Res, mtl flm, 237Ω, ±1%, 1/8W | 328005 | 91637 | MFF1-82370F | 1 | | |
| R25 | Res, fxd WW, 1Ω, ±1%, 150V, 2W | 229534 | 91637 | RS2C70GF | REF | | |
| R26 | Res, mtl flm, 1.10K, ±1%, 1/8W | 241497 | 91637 | MFF1-81101F | REF | | |
| R27 | Res, comp, 1.8K, ±5%, ½W | 109140 | 01121 | EB1825 | REF | | |
| R28 | Res, comp, 130Ω, ±5%, ¼W | 325704 | 01121 | CB1315 | REF | | |
| R29 | Res, comp, 3.3K, ±5%, ½W | 165761 | 01121 | EB3325 | REF | | |
| R30 | Res, comp, 1.3K, ±5%, ½W | 109157 | 01121 | EB1325 | 1 | | |
| R31 | Res, comp, 3.9K, ±5%, ¼W | 148064 | 01121 | CB3925 | 1 | | |
| R32 | Res, comp, 51Ω, ±5%, ¼W | 221879 | 01121 | CB5105 | REF | | |
| R33 | Res, comp, 12K, ±5%, ¼W | 159731 | 01121 | CB1235 | REF | | |
| R34 | Res, comp, 100Ω, ±5%, ¼W | 147926 | 01121 | CB1015 | REF | | |
| R35 | Res, fxd, WW, 0.15, ±10%, 2W | 325712 | 81483 | BWHR15K | REF | | |
| R36 | Res, comp, 820Ω, ±5%, ¼W | 148015 | 01121 | CB8215 | REF | | |
| R37 | Res, comp, 3Ω, ±5%, ¼W | 218040 | 01121 | CB30G5 | REF | | |
| R38, R39, CR21 | Reference Assembly | 325266 | 89536 | 325266 | 1 | | |
| R40 | Res, var, CERMET, 50Ω, ±10%, ½W | 285122 | 71450 | 360S-500A | 1 | | |
| R41 | Res, mtl flm, 2.80K, ±1%, 1/8W | 325670 | 91637 | MFF1-82801F | 1 | | |
| R42 | Res, mtl flm, 866Ω, ±1%, ½W | 151233 | 91637 | MFF1-2660 | 1 | | |
| R43 | Res, comp, 1.8K, ±5%, ½W | 109140 | 01121 | EB1825 | REF | | |
| R44 | Res, mtl flm, 1.43K, ±1%, 1/8W | 325662 | 91637 | MFF1-81431F | REF | | |
| R45 | Res, mtl flm, 210Ω, ±1%, 1/8W | 327999 | 91637 | MFF1-82100F | 1 | | |
| R46 | Res, WW, 0.27Ω, ±1%, 5W | 325696 | 11502 | AS-5 | 1 | | |
| R47 | Res, fxd WW, 1Ω, ±1%, 150V, 2W | 229534 | 91637 | RS2C70GF | REF | | |

## POWER SUPPLY PCB ASSEMBLY, A12

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| R48 | Res, comp, 2.7K, ±5%, 1W | 296422 | 01121 | GB2725 | 1 | | |
| R49 | Res, comp, 130Ω, ±5%, ¼W | 325704 | 01121 | CB1315 | REF | | |
| R50 | Res, comp, 510Ω, ±5%, ¼W | 218032 | 01121 | CB5115 | 1 | | |
| R51 | Res, comp, 1.2K, ±5%, ¼W | 190371 | 01121 | CB1225 | 1 | | |
| R52 | Res, comp, 51Ω, ±5%, ¼W | 221879 | 01121 | CB5105 | REF | | |
| R53 | Res, comp, 620Ω, ±5%, ¼W | 221903 | 01121 | CB6215 | 1 | | |
| R54 | Res, comp, 2Ω, ±5%, ¼W | 202879 | 01121 | CB2025 | | | |
| R55, R56 | Res, fxd, WW, 0.30Ω, ±5%, 2W | 219410 | 75042 | BWHR30J | 2 | | |
| R57 | Res, comp, 820Ω, ±5%, ¼W | 148015 | 01121 | CB8215 | REF | | |
| R58 | Res, comp, 3Ω, ±5%, ¼W | 218040 | 01121 | CB30G5 | REF | | |
| R59 | Res, mtl flm, 4.99K, ±.25%, ¼W | 267625 | 91737 | MFF1-44991P | 1 | | |
| R60 | Res, mtl flm, 11.8K, ±1%, 1/8W | 325688 | 91632 | MFF1-81182F | 1 | | |
| R61 | Res, mtl flm, 200Ω, ±1%, 1/8W | 245340 | 91637 | MFF1-82000F | 1 | | |
| U1, U2, U3 | IC, operational amplifier | 271502 | 07263 | LM301A | 3 | 1 | |
| | Xstr Pad | 296319 | 32559 | T0806 | 4 | | |

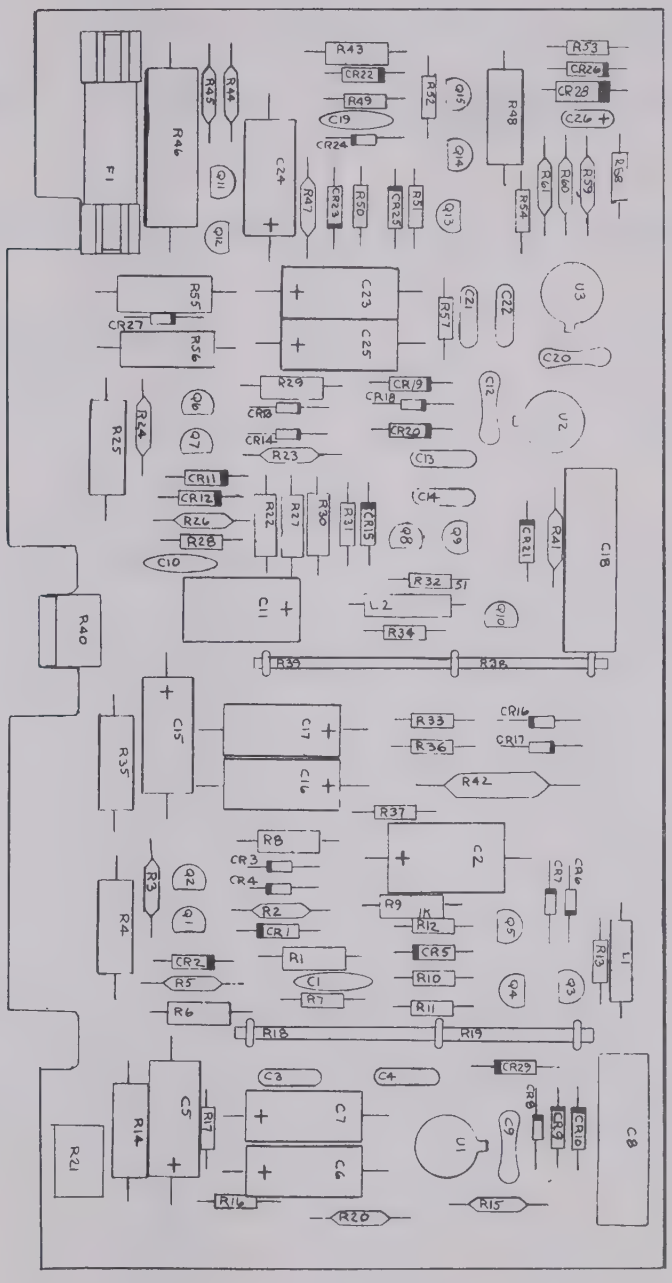


Figure 5-27. POWER SUPPLY PCB ASSEMBLY, A12

## MOTHER BOARD PCB ASSEMBLY, A13

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A13 | **MOTHER BOARD PCB ASSEMBLY**<br>**Figure 5-28 6160B-4013** | 356295 | 89536 | 356295 | REF | | |
| J10 thru J13 | Connector, rcpt. 20 pin | 292912 | 02660 | 225-21021-110 | 5 | | |
| CR1 thru CR4 | Diode, si, 3 Amp | 187716 | 04713 | MR1032B/ 1N4999 | 4 | 1 | |
| CR5, CR6 | Diode, si, rectifier | 325746 | 04713 | MR751 | 2 | 1 | |
| J15 | Socket, tube | 100495 | 95354 | PM465 | 1 | | |
| | Terminal post | 267500 | 00779 | 86144-2 | 34 | | |

## MOTHER BOARD PCB ASSEMBLY, A13

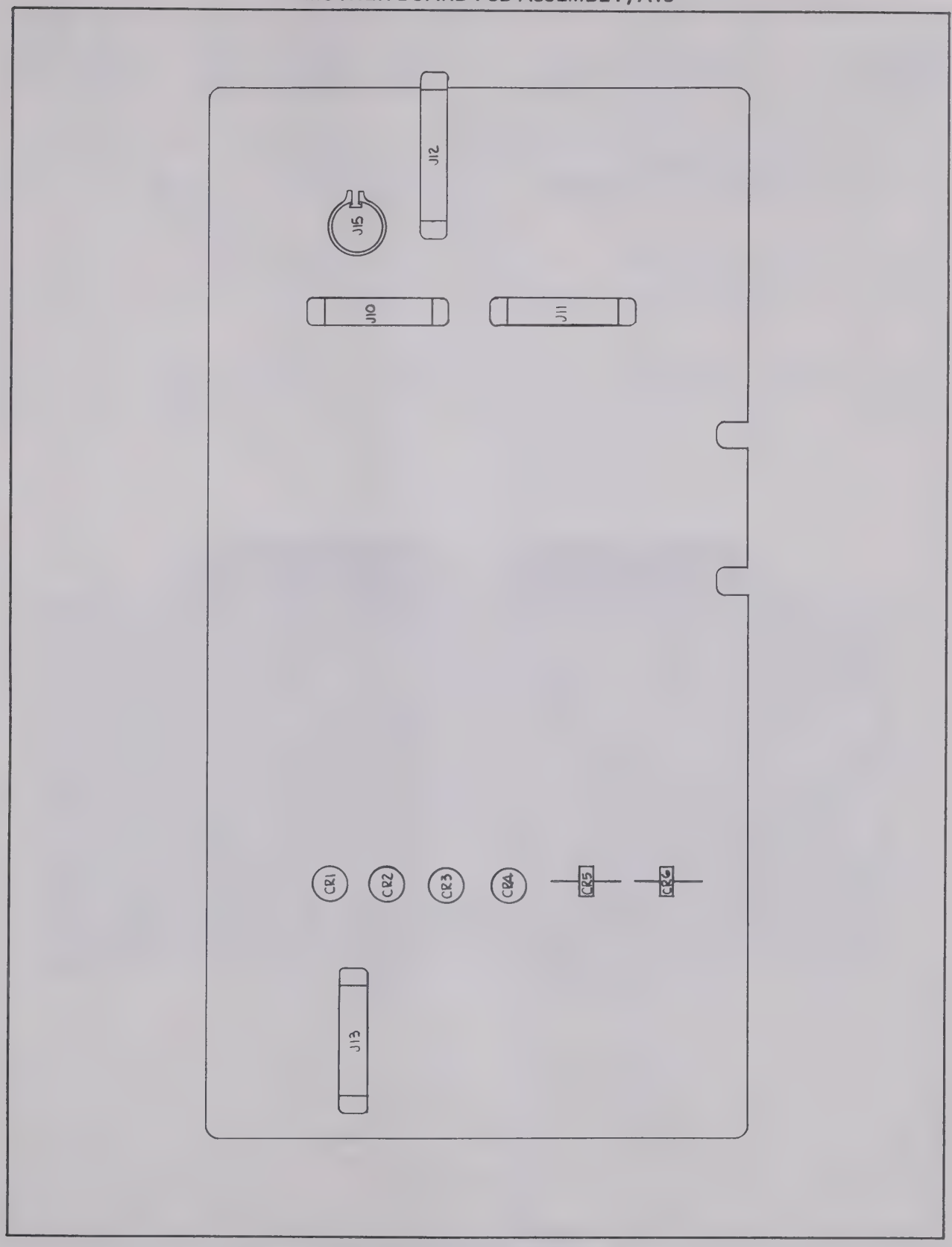


Figure 5-28. MOTHER BOARD PCB ASSEMBLY, A13

## RISER PCB ASSEMBLY, A14

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A14 | **RISER PCB ASSEMBLY**<br>**Figure 5-29 6160A-4015** | 323147 | 89536 | 323147 | REF | | |
| J1, J2 | Connector, 20 pin contact | 292912 | 72660 | 225-21021-110 | 2 | | |

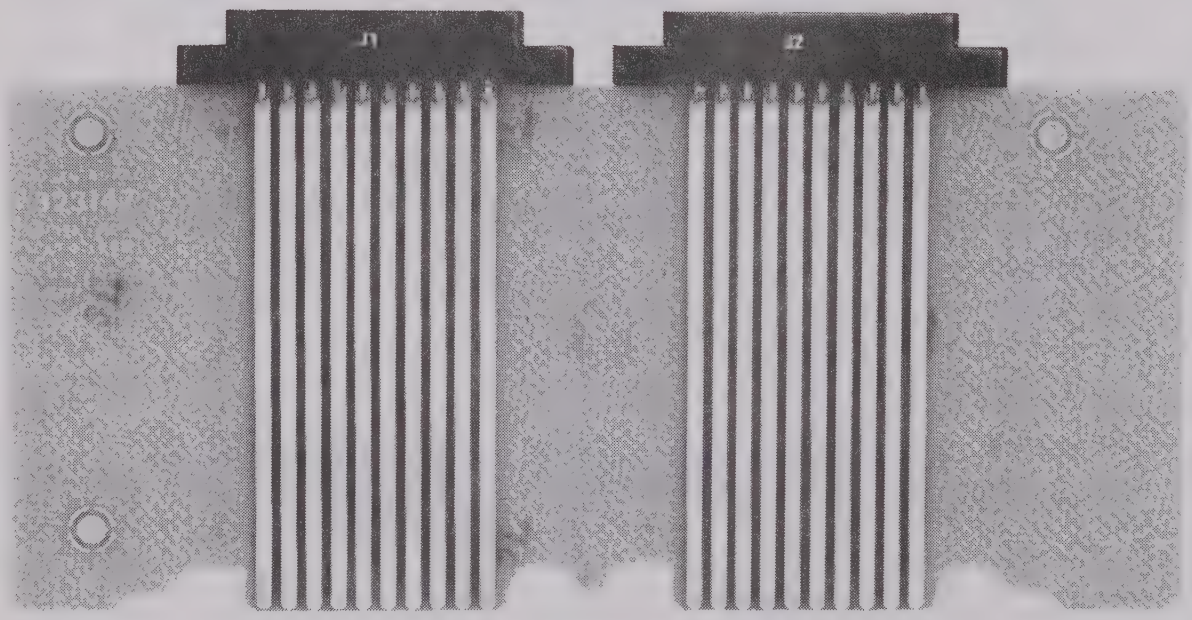


Figure 5-29. RISER PCB ASSEMBLY

## TRANSFORMER ENCLOSURE ASSEMBLY, A15

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A15 | **TRANSFORMER ENCLOSURE ASSEMBLY 6160A-4116** **Figure 5-30** | 323493 | 89536 | 323493 | REF | | |
| C1, C2, C3, C4 | Cap, cer, 0.005 uf ±20%, 1000V | 105650 | 56289 | C023B102H-502M | 4 | | |
| F1, F2 | Fuse, slo-blo, 1.5A | 109231 | 71400 | MDS1R5A250V | 2 | 5 | |
| FL1 | Filter, line,3A | 321273 | 05245 | 3EF2 | 1 | | |
| S1 | Switch, 115/230V | 226274 | 82389 | 46256-LFR | 1 | | |
| T1 | XFmr, power | 324434 | 89536 | 324434 | 1 | | |
| XF1, XF2 | Fuse holder | 160846 | 75915 | 342004 | 2 | | |
| 1 | Nut, kep, #8 - 32 | 195263 | 78199 | 51108180000 | 6 | | |
| 2 | Nut, kep, #6 - 32 | 195263 | 78199 | 51106180000 | 2 | | |
| 3 | PCB, xfmr connector | 323642 | 89536 | 323642 | 1 | | |
| 4 | Screw, 6 - 32 x 3/8, FLH - Phillips | 114363 | 73734 | 18244 | 6 | | |
| 5 | Screw, 8 - 32 x 3/8, FLH - Phillips | 114116 | 73734 | 18264 | 4 | | |
| 6 | Screw, 8 - 32 x 3/8, PNH - Phillips | 114124 | 73734 | 19064 | 4 | | |
| 7 | Screw, 6 - 32 x 3/8, SEMS | 177022 | 73734 | 6-32 x 3/8 SEMS | 4 | | |
| 8 | xfmr enclosure | 323345 | 89536 | 323345 | 1 | | |
| 9 | xfmr enclosure, top | 323352 | 89536 | 323352 | 1 | | |

## TRANSFORMER ENCLOSURE ASSEMBLY, A15

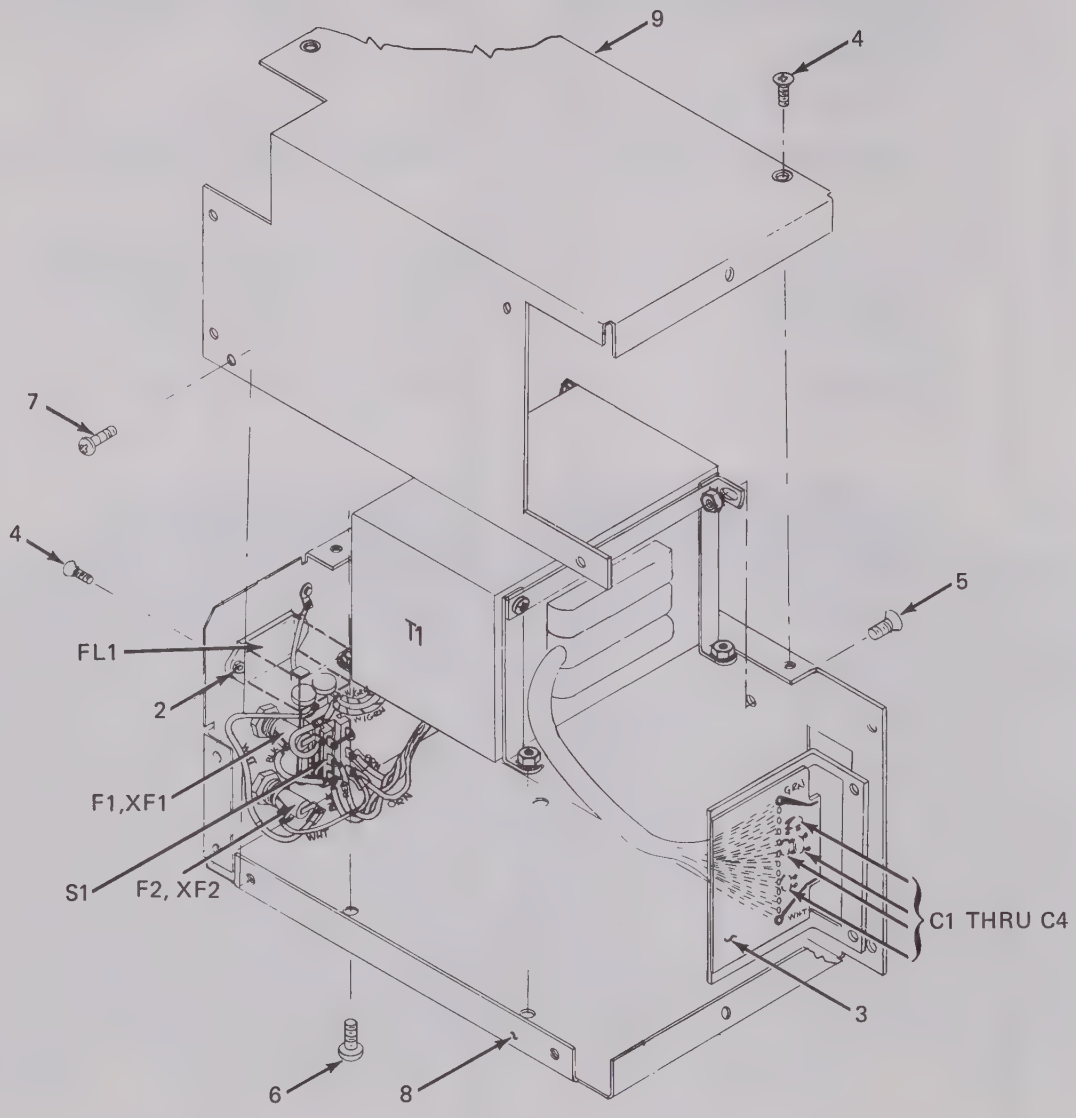


Figure 5-30. TRANSFORMER ENCLOSURE ASSEMBLY, A15

## HEAT SINK ASSEMBLY, A16

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A16 | **HEAT SINK ASSEMBLY** Figure 5-31 6160A-4021 | 323154 | 89536 | 323154 | REF | | |
| J1 | Connector, board-edge, receptical, 20 pin | 292912 | 02660 | 225-21021-110 | 1 | | |
| Q1,Q5 | Xstr, si, NPN | 325720 | 04713 | MJE3055 | 2 | 1 | |
| Q2,Q6 | Xstr, si NPN | 325761 | 06001 | D4465 | 2 | 1 | |
| Q3 | Xstr, si, PNP | 325738 | 04713 | MJE2955 | 1 | 1 | |
| Q4 | Xstr, si, PNP | 325753 | 06001 | D4565 | 1 | 1 | |
| R1, R2, R3 | Res, comp, 620Ω, ±5%, ¼W | 221903 | 01121 | CB6215 | 3 | | |
| 1 | Heat sink | 252684 | 89536 | 252684 | 1 | | |
| 2 | Insulator, xstr mounting | 331116 | 13103 | 4778A | 3 | | |
| 3 | Lug, solder, #6 | 132399 | 78189 | 2104-06-00 | 1 | | |
| 4 | Screw, 4-40 x 1, PNH - Phillips | 157008 | 73734 | 12030 | 2 | | |
| 5 | Screw, 6-32 x ¼, PNH - Phillips | 152140 | 73734 | 19042 | 1 | | |
| 6 | Screw, nylon with steel core, 6-32 x ¼, RDH - Phillips | 272799 | 23050 | 6-32x1-4NYL STLRDH | 3 | | |
| 7 | Screw, 6-32 x 3/8, PNH - Phillips | 152165 | 73734 | 19044 | 3 | | |
| 8 | Standoff, insulator, #6 | 163592 | 89536 | 163592 | 2 | | |
| 9 | Washer, flat, #4 | 110775 | 73734 | 1442 | 2 | | |
| 10 | Washer, internal lock, #4 | 110403 | 73734 | 99402 | 2 | | |
| 11 | Washer, flat, #6 | 110270 | 73734 | AN960-616L | 1 | | |

## HEAT SINK ASSEMBLY, A16

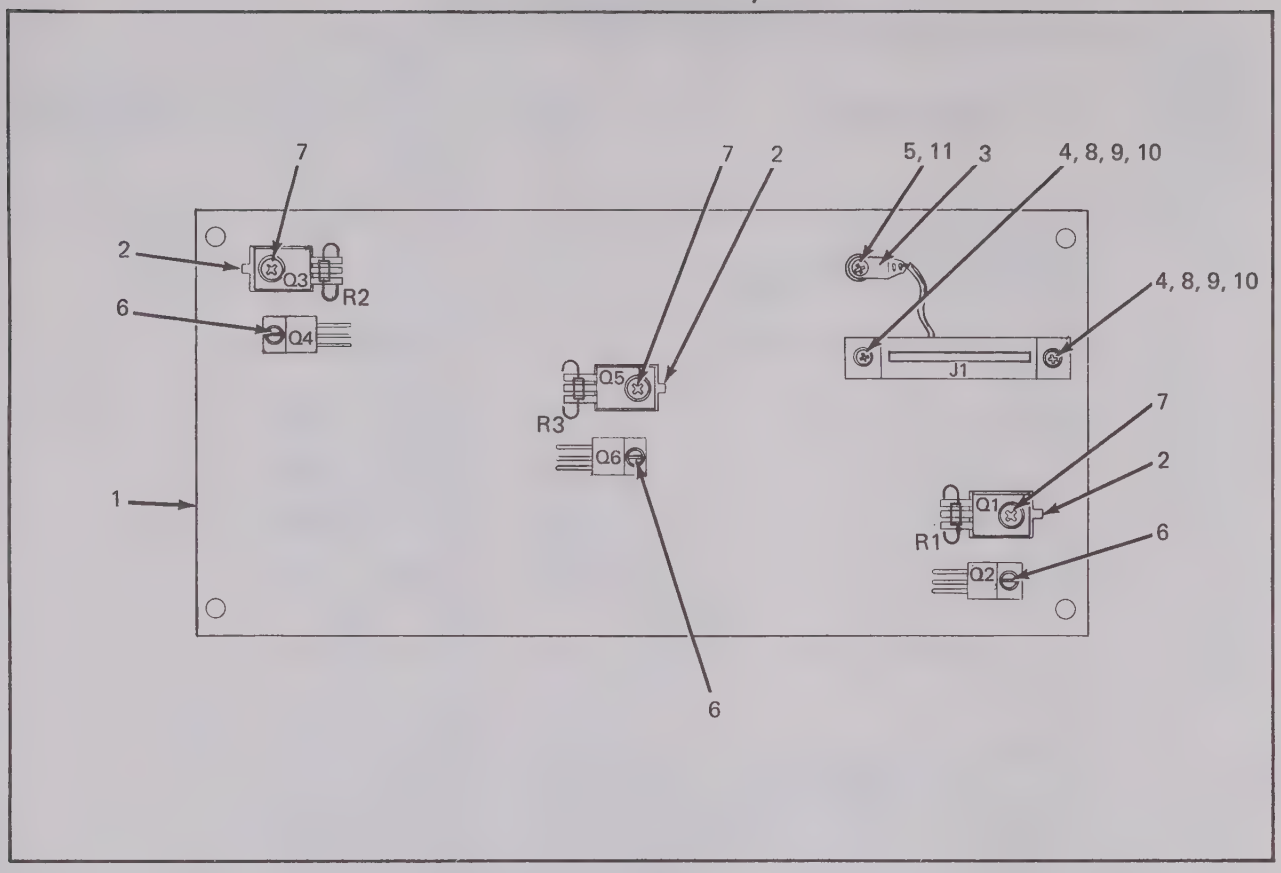


Figure 5-31. HEAT SINK ASSEMBLY, A16

## REAR PANEL ASSEMBLY, A17

| REF DESIG OR ITEM NO. | DESCRIPTION | FLUKE STOCK NO. | MFG FED SPLY CDE | MFG PART NO. OR TYPE | TOT QTY | REC QTY | USE CDE |
|---|---|---|---|---|---|---|---|
| A17 | **REAR PANEL ASSEMBLY**<br>**Figure 5-32 6160A-4452** | 324616 | 89536 | 324616 | REF | | |
| 1 | Rear Panel, screened | 323337 | 89536 | 323337 | 1 | | |
| 2 | Washer, flat #8 | 110288 | 73734 | 97425 | 4 | | |
| 3 | Foot, rear | 324897 | 89536 | 324897 | 4 | | |
| 4 | Screw, 8 - 32 x 5/8 PNH - Phillips | 114983 | 73734 | 19067 | 4 | | |
| 5 | Washer, internal lock, #8 | 110320 | 73734 | 99405 | 4 | | |
| 6 | Hole plug - 5/8" | 222711 | 72653 | 1713 - C | 1 | | |
| 7 | Hole plug - ½" | 101774 | 72653 | 1712 - C | 2 | | |
| 8 | Screw, 6 - 32 x ¼, PNH - Phillips (SEMS) | 178533 | 73734 | 6-32x1-4PNH SEMS | 4 | | |
| 9 | Bracket, card slide | 323287 | 89536 | 323287 | 1 | | |
| 10 | Connector, BNC, LEVEL CONTROL INPUT | 152033 | 95712 | 30355-1 | 1 | | |
| 11 | Cable Assy, RF #2 | 259747 | 89536 | 259747 | 1 | | |
| 12 | Cable Assy, RF #1 | 269969 | 89536 | 269969 | 1 | | |
| 13 | Cable Assy, RF #24 | 270264 | 89536 | 270264 | 1 | | |
| 14 | Cable Assy, RF #23 | 333096 | 89536 | 333096 | 1 | | |

## REAR PANEL ASSEMBLY, A17

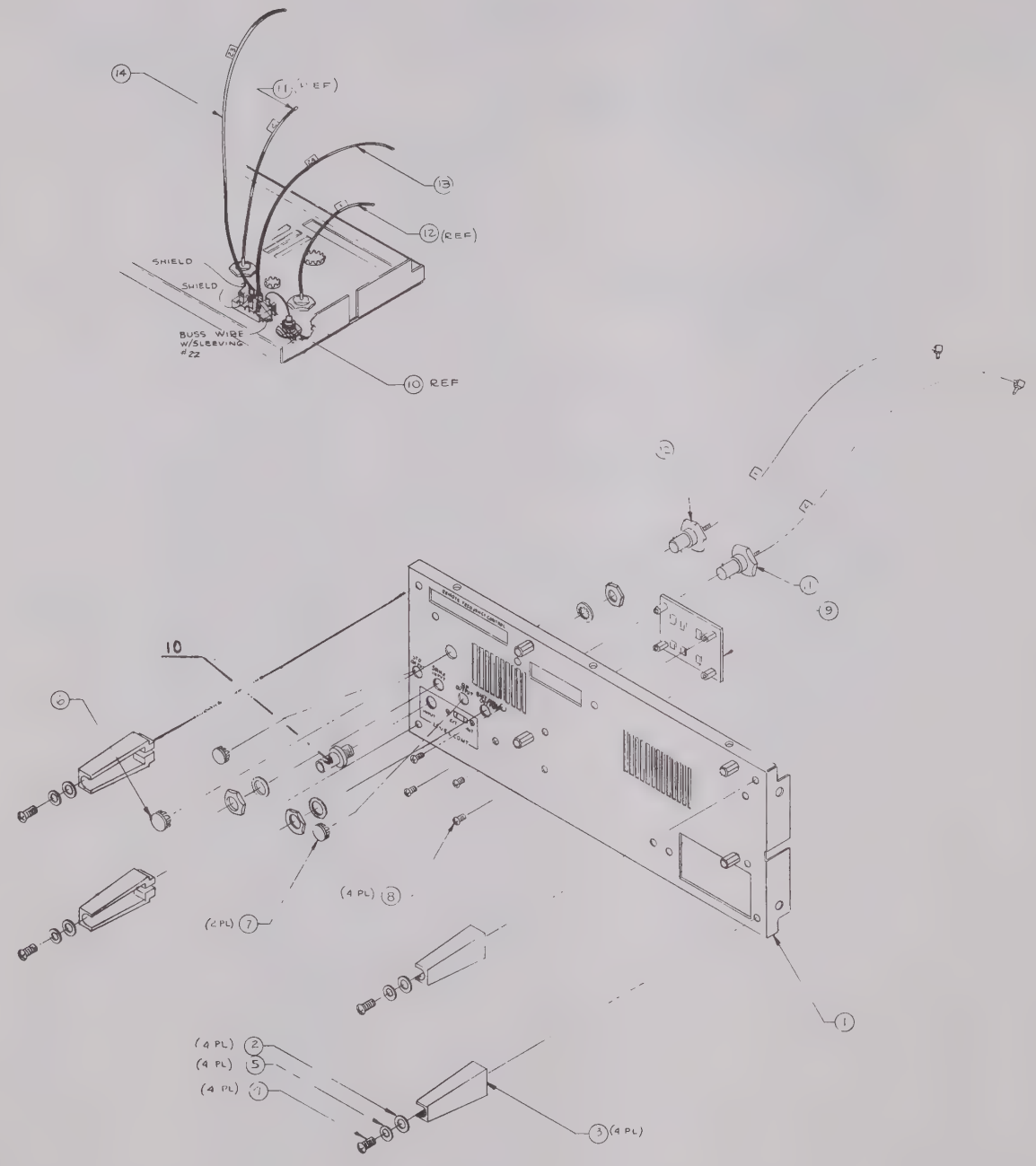


Figure 5-32. REAR PANEL ASSEMBLY, A17

# Section 6
# Option & Accessory Information

## 6-1. FREQUENCY STANDARD, OPTION –02

### 6-2. Introduction

6-3. The –02 Option is a 5 MHz oscillator assembly with a rated stability of 2 parts in $10^9$ per 24 hours. The oscillator eliminates the need for an external 5 MHz source to drive the synthesizer. The oscillator is ovenized for stability and temperature is maintained as long as ac power is connected to the unit.

### 6-4. Operation

6-5. Operation of the 6160B with the –02 Option installed is the same as that described in Section 2 for the standard unit, except that no external 5 MHz source need be applied. The 5 MHz oscillator is automatically maintained at operating temperature when the front-panel FUNCTION switch is in the OFF position, as long as ac power is connected.

### 6-6. Theory of Operation

6-7. Although the oscillator itself is considered non-repairable, the operation of the associated pcb is repairable, and is described in the following text with reference to the A15, Internal Frequency Standard (Option –02) schematic diagram, drawing 6160A-1018. During normal operation, the 5 MHz oscillator operates from the regulated +14-volt and –12-volt supplies. The unregulated +14-volt supply is disconnected by means of Q1, which is cut-off by the front-panel FUNCTION switch.

6-8. When the FUNCTION switch is placed in the OFF position, Q1 conducts to apply the +14-volt unregulated supply to the oscillator oven in order to maintain temperature. Diode CR3 prevents the +14-volt unregulated supply from feeding circuits normally powered by the +14-volt regulated supply.

### 6-9. List of Replaceable Parts

6-10. For column entry explanations, part ordering information and basic instrument configuration, refer to Section 5 of the manual.

| REF DESIG | DESCRIPTION | STOCK NUMBER | TOT QTY | REC QTY | USE CODE |
|---|---|---|---|---|---|
| A15 | **INTERNAL FREQUENCY STANDARD ASSY. –01, –02 OPTION, (6160A-4018) Figure 5-16** | | | | |
| | –02 Option, $2x10^{-9}$ per day drift rate | 315440 | REF | | |
| A15A1 | 5 MHz standard oscillator (–02 Option) | 285577 | 1 | | |
| A15A2 | Frequency standard assembly | 324822 | 1 | | |
| | Cable, coax, Jumper assembly | 172809 | 1 | | |
| | Cable, RF, assembly | 259705 | 1 | | |
| A15A2 | **FREQUENCY STANDARD ASSEMBLY** | 324822 | REF | | |
| C1, C2 | Cap, cer, 0.05 uf +80/-20%, 25V | 148924 | 2 | | |
| CR1, CR2, CR3 | Diode, silicon, 1 amp, 100 piv | 116111 | 3 | | |
| L1, L2 | Bead, 6 turn | 320911 | 2 | | |
| Q1 | Tstr, silicon, PNP | 218537 | 1 | | |
| R1 | Res, comp, 1k ±5%, 1/4w | 148023 | 1 | | |
| R2 | Res, comp, 1.5k ±5%, 1/4w | 148031 | 1 | | |
| XY1 | Socket, tube | 100479 | 1 | | |
| | Cable, RF | 259705 | 1 | | |

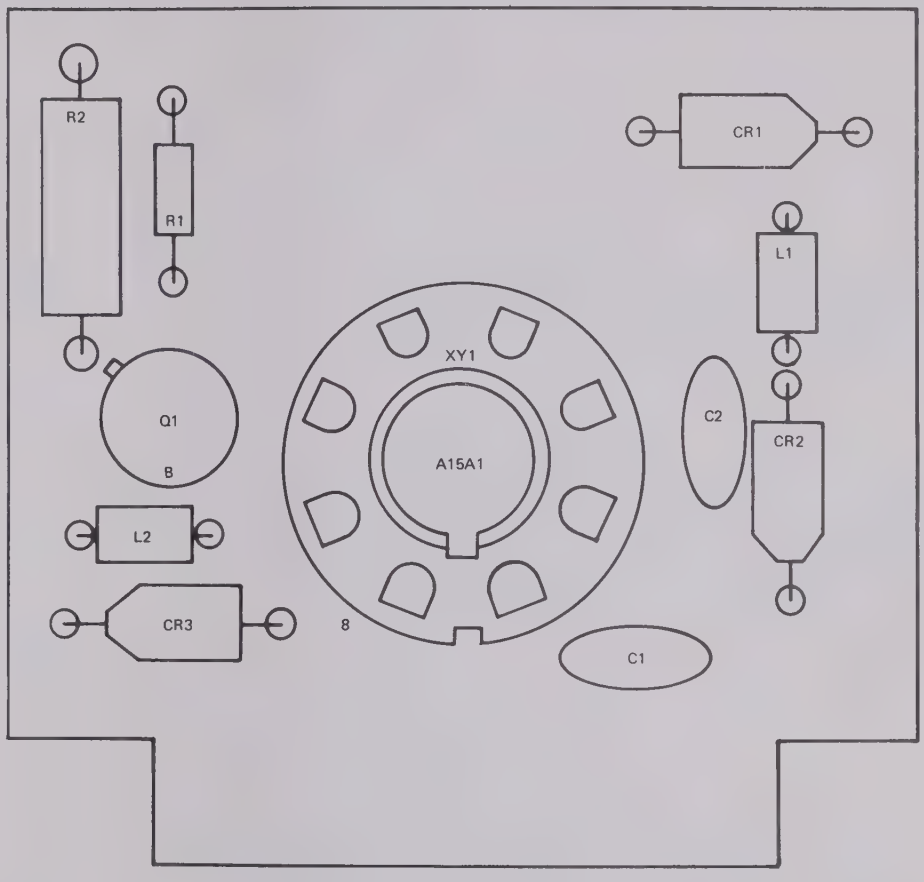


Figure 6-1. INTERNAL FREQUENCY STANDARD ASSEMBLY, –02 OPTION

## 6-11. REAR PANEL RF OUTPUT, OPTION –04

6-12. The –04 option comprises an rf cable and output connector mounted on the rear panel, in place of the standard output connector on the front panel. The rf output characteristics and specifications for the rear panel connector are identical to those specified for the standard front panel rf output connector.

## 6-13. TCXO, OPTION –05

6-14. The –05 Option for the 6160B is a 5 MHz TCXO (temperature compensated crystal oscillator) which has a specified stability of five parts in $10^6$ per year. The TCXO eliminates the need for an external 5 MHz source to drive the synthesizer. The oscillator is a non-repairable assembly (Fluke part number 362798) which mounts in the rear portion of the unit. DC power and the 5 MHz output connections are all made to terminals on the Mother Board PCB Assembly, A13.

# Section 7
# General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable parts contained in Section 5. The following information is presented in this section:

List of Abbreviations
Federal Supply Codes for Manufacturers
Fluke Technical Service Centers — U.S. and Canada
Sales and Service Locations — International
Sales Representatives — U.S. and Canada

| | |
|---|---|
| A or amp | ampere |
| ac | alternating current |
| af | audio frequency |
| a/d | analog-to-digital |
| assy | assembly |
| AWG | american wire gauge |
| B | bel |
| bcd | binary coded decimal |
| $^{o}C$ | Celsius |
| cap | capacitor |
| ccw | counterclockwise |
| cer | ceramic |
| cermet | ceramic to metal(seal) |
| ckt | circuit |
| cm | centimeter |
| cmrr | common mode rejection ratio |
| comp | composition |
| cont | continue |
| crt | cathode-ray tube |
| cw | clockwise |
| d/a | digital-to-analog |
| dac | digital-to-analog converter |
| dB | decibel |
| dc | direct current |
| dmm | digital multimeter |
| dvm | digital voltmeter |
| elect | electrolytic |
| ext | external |
| F | farad |
| $^{o}F$ | Fahrenheit |
| FET | Field-effect transistor |
| ff | flip-flop |
| freq | frequency |
| FSN | federal stock number |
| g | gram |
| G | giga ($10^{9}$) |
| gd | guard |
| Ge | germanium |
| GHz | gigahertz |
| gmv | guaranteed minimum value |
| gnd | ground |
| H | henry |
| hd | heavy duty |
| hf | high frequency |
| Hz | hertz |
| IC | integrated circuit |
| if | intermediate frequency |
| in | inch(es) |
| intl | internal |
| I/O | input/output |
| k | kilo ($10^{3}$) |
| kHz | kilohertz |
| kΩ | kilohm(s) |
| kV | kilovolt(s) |
| lf | low frequency |
| LED | light-emitting diode |
| LSB | least significant bit |
| LSD | least significant digit |
| M | mega ($10^{6}$) |
| m | milli ($10^{-3}$) |
| mA | milliampere(s) |
| max | maximum |
| mf | metal film |
| MHz | megahertz |
| min | minimum |
| mm | millimeter |
| ms | millisecond |
| MSB | most significant bit |
| MSD | most significant digit |
| MTBF | mean time between failures |
| MTTR | mean time to repair |
| mV | millivolt(s) |
| mv | multivibrator |
| MΩ | megohm(s) |
| n | nano ($10^{-9}$) |
| na | not applicable |
| NC | normally closed |
| (–) or neg | negative |
| NO | normally open |
| ns | nanosecond |
| opnl ampl | operational amplifier |
| p | pico ($10^{-12}$) |
| para | paragraph |
| pcb | printed circuit board |
| pF | picofarad |
| pn | part number |
| (+) or pos | positive |
| pot | potentiometer |
| p-p | peak-to-peak |
| ppm | parts per million |
| PROM | programmable read-only memory |
| psi | pound-force per square inch |
| RAM | random-access memory |
| rf | radio frequency |
| rms | root mean square |
| ROM | read-only memory |
| s or sec | second (time) |
| scope | oscilloscope |
| SH | shield |
| Si | silicon |
| serno | serial number |
| sr | shift register |
| Ta | tantalum |
| tb | terminal board |
| tc | temperature coefficient or temperature compensating |
| tcxo | temperature compensated crystal oscillator |
| tp | test point |
| u or μ | micro ($10^{-6}$) |
| uhf | ultra high frequency |
| us or μs | microsecond(s) ($10^{-6}$) |
| uut | unit under test |
| V | volt |
| v | voltage |
| var | variable |
| vco | voltage controlled oscillator |
| vhf | very high frequency |
| vlf | very low frequency |
| W | watt(s) |
| ww | wire wound |
| xfmr | transformer |
| xstr | transistor |
| xtal | crystal |
| xtlo | crystal oscillator |
| Ω | ohm(s) |
| μ | micro ($10^{-6}$) |

## Federal Supply Codes for Manufacturers (Continued)

00213
Nytronics Comp. Group Inc.
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisberg, Pennsylvania

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics Inc.
Manchester, New Hampshire

01730
Replaced by 73586

01884 - use 56289
Sprague Electric Co.
Dearborn Electronic Div.
Lockwood, Florida

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Harris ASW Div.
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Snelgrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 1M2

02606
Fenwal Labs
Div. of Travenal Labs.
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div.
Formerly Amphenol-Borg
Electric Corp.
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products
Syracuse, New York

03614
Replaced by 71400

03651
Replaced by 44655

03797
Eldema Div.
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp.
Whippany, New Jersey

03911
Clairex Electronics Div.
Clairex Corp.
Mt. Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222
AVX Ceramics Div.
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc.
Chicago, Illinois

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp.
Materials Systems Div.
New York, New York

05571 - use 56289
Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Electronic Capacitor &
Battery Products Dept.
Columbia, South Carolina

06136
Replaced by 63743

06383
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol SAMS Div.
Chatsworth, California

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06739
Electron Corp.
Littleton, Colorado

06743
Clevite Corp.
Cleveland, Ohio

06751
Components, Inc. Semcor Div.
Phoenix, Arizona

06860
Gould Automotive Div.
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div.
Bedford, Ohio

06980
Eimac Div.
Varian Associates
San Carlos, California

07047
Ross Milton, Co., The
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Division
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp.
Div. of BBF Group Inc.
Chelmsford, MA

07261
Aumet Corp.
Culver City, California

07263
Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344
Bircher Co., Inc.
Rochester, New York

07597
Burndy Corp.
Tape/Cable Div.
Rochester, New York

07792
Lerma Engineering Corp.
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933 - use 49956
Raytheon Co.
Semiconductor Div. HQ
Mountain View, California

08225
Industro Transistor Corp.
Long Island City, New York

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

08806
General Electric Co.
Miniature Lamp Products Dept.
Cleveland, Ohio

08863
Nylomatic Corp.
Norrisville, Pennsylvania

08988 - use 53085
Skottie Electronics Inc.
Archbald, Pennsylvania

09214
G.E. Co. Semi-Conductor
Products Dept.
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components, Inc.
Santa Barbara, California

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

10059
Barker Engineering Corp.
Formerly Amerace, Amerace
ESNA Corp.
Kenilworth, New Jersey

11236
CTS of Berne
Berne, Indiana

11237
CTS Keene Inc.
Paso Robles, California

11358
CBS Electronic Div.
Columbia Broadcasting System
Newburyport, MN

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

11711
General Instrument Corp
Rectifier Division
Hickville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12040
National Semiconductor Corp.
Danburry, Connecticut

12060
Diodes, Inc.
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12300
Potter-Brumfield Division
AMF Canada LTD.
Guelph, Onatrio, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp. formerly
Freeway Washer & Stamping Co.
Cleveland, Ohio

12443
Budd Co. The, Polychem Products
Plastic Products Div.
Bridgeport, PA

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12749
James Electronics
Chicago, Illinois

12856
Micrometals
Sierra Madre, California

12954
Dickson Electronics Corp.
Scottsdale, Arizona

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Amphenol Cadre Div.
Bunker-Ramo Corp.
Los Gatos, California

13606 - use 56289
Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp.
Newbury Park, California

14140
Edison Electronic Div.
Mc Gray-Edison Co.
Manchester, New Hampshire

14193
Cal-R-Inc. formerly
California Resistor, Corp.
Santa Monica, California

14298
American Components, Inc.
an Insilco Co.
Conshohocken, Pennsylvania

14655
Cornell-Dublier Electronics
Division of Federal Pacific
Electric Co. Govt. Control Dept.
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp.
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Trol Inc.
Saugus, California

15801
Fenwal Electronics Inc.
Div. of Kidde Walter and Co., Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors, formerly
Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc.
Burbank, California

16299
Corning Glass
Electronic Components Div.
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Div. of Chemed Corporation
Cambridge, Maryland

16742
Paramount Plastics Fabricators, Inc.
Downey, California

16758
Delco Electronics
Div. of General Motors Corp.
Kokomo, Indiana

17001
Replaced by 71468

17069
Circuit Structures Lab.
Burbank, California

17338
High Pressure Eng. Co., Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc.
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc.
Maryland Heights, Missouri

18324
Signetics Corp.
Sunnyvale, California

18612
Vishay Resistor Products Div.
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18736
Voltronics Corp.
Hanover, New Jersey

18927
G T E Sylvania Inc.
Precision Material Group
Parts Division
Titusville, Pennsylvania

19451
Perine Machinery & Supply Co.
Seattle, Washington

19701
Electro-Midland Corp.
Mepco-Electra Inc.
Mineral Wells, Texas

20584
Enochs Mfg. Inc.
Indianapolis, Indiana

20891
Self-Organizing Systems, Inc.
Dallas, Texas

21604
Buckeye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Transistor Division
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Inc.
Rockville, Maryland

23880
Stanford Applied Engrng.
Santa Clara, California

23936
Pamotor Div., Wm. J. Purdy Co.
Burlingame, California

24248
Replaced by 94222

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

24759
Lenox-Fugle Electronics Inc.
South Plainfield, New Jersey

25088
Siemen Corp.
Isilen, New Jersey

25403
Amperex Electronic Corp.
Semiconductor &
Micro-Circuits Div.
Slatersville, Rhode Island

27014
National Semiconductor Corp.
Santa Clara, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
Consumer Products Div.
St. Paul, Minnesota

28425
Serv-/-Link formerly
Bohannan Industries
Fort Worth, Texas

28478
Deltrol Controls Div.
Deltrol Corporation
Milwaukee, Wisconsin

28480
Hewlett Packard Co. Corporate H.Q.
Palo Alto, California

28520
Heyman Mfg. Co.
Kenilworth, New Jersey

29083
Monsanto, Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30148
A B Enterprise Inc.
Ahoskie, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

31091
Optimax Inc.
Colmar, Pennsylvania

32539
Mura Corp.
Great Neck, New York

32767
Griffith Plastic Corp.
Burlingame, California

32879
Advanced Mechanical Components
Northridge, California

32897
Erie Technological Products, Inc.
Frequency Control Div.
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Products Division
Riverside, California

33173
General Electric Co.
Products Dept.
Owensboro, Kentucky

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

37942
Mallory, P.R. & Co., Inc.
Indianapolis, Indiana

42498
National Radio
Melrose, Massachusetts

43543
Nytronics Inc.
Transformer Co. Div.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

54294
Cutler-Hammer Inc. formerly
Shallcross, A Cutter-Hammer Co.
Selma, North Carolina

55026
Simpson Electric Co.
Div. of Am. Gage and Mach. Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

60399
Torin Corp, formerly
Torrington Mfg. Co.
Torrington, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

64834
West Mfg. Co.
San Francisco, Californai

65092
Weston Instruments Inc.
Newark, New Jersey

66150
Winslow Tele-Tronics Inc.
Eaton Town, New Jersey

70485
Atlantic India Rubber Works
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71002
Birnbach Radio Co., Inc.
Freeport, LI New York

71400
Bussmann Mfg.
Div. of McGraw-Edison Co.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare, C.P. & Co.
Chicago, Illinois

71590
Centrelab Electronics
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707
Coto Coil Co., Inc.
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Cinch Connector Operations Div.
Elk Grove Village, Chicago, Illinois

72005
Driver, Wilber B., Co.
Newark, New Jersey

72092
Replaced by 06980

72136
Electro Motive Mfg. Co.
Williamantic, Connecticut

72259
Nytronics Inc.
Pelham Manor, New Jersey

72619
Dialight Div.
Amperex Electronic Corp.
Brooklyn, New York

72653
G.C. Electronics
Div. of Hydrometals, Inc.
Brooklyn, New York

72665
Replaced by 90303

72794
Dzus Fastener Co., Inc.
West Islip, New York

72928
Gulton Ind. Inc.
Gudeman Div.
Chicago, Illinois

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Beckman Instruments Inc.
Helipot Division
Fullerton, California

73293
Hughes Aircraft Co.
Electron Dynamics Div.
Torrence, California

73445
Amperex Electronic Corp.
Hicksville, LI, New York

73559
Carling Electric Inc.
West Hartford, Connecticut

73586
Circle F Industries
Trenton, New Jersey

73734
Federal Screw Products, Inc.
Chicago, Illinois

73743
Fischer Special Mfg. Co.
Cincinnati, Ohio

73899
JFD Electronics Co.
Components Corp
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74199
Quan Nichols Co.
Chicago, Illinois

74217
Radio Switch Corp.
Marlboro, New Jersey

74276
Signalite Div.
General Instrument Corp.
Neptune, New Jersey

74306
Piezo Crystal Co.
Carlisle, Pennsylvania

74542
Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970
Johnson E.F., Co.
Waseca, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75376
Kurz-Kasch Inc.
Dayton, Ohio

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

76854
Oak Industries Inc.
Switch Div.
Crystal Lake, Illinois

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, Indiana

77638
General Instrument Corp.
Rectifier Division
Brooklyn, New York

77969
Rubbercraft Corp. of CA. LTD.
Torrance, California

78189
Shakeproof
Div. of Illinois Tool Works Inc.
Elgin, Illinois

78277
Sigma Instruments, Inc.
South Braintree, Massachusetts

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp. Engineered
Fastener Div.
Tinnerman Plant
Cleveland, Ohio

79136
Waldes Kohinoor Inc.
Long Island City, New York

79497
Western Rubber Company
Goshen, Indiana

79963
Zierick Mfg. Corp.
Mt. Kisko, New York

80031
Electro-Midland Corp., Mepco Div.
A North American Phillips Co.
Morristown, New Jersey

80145
LFE Corp., Process Control Div.
formerly API Instrument Co.
Chesterland, Ohio

80183 - use 56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div.
Riverside, California

80583
Hammarlund Mfg. Co., Inc.
Red Bank, New Jersey

80640
Stevens, Arnold Inc.
South Boston, Massachusetts

81073
Grayhill, Inc.
La Grange, Illinois

81312
Winchester Electronics
Div. of Litton Industries Inc.
Oakville, Connecticut

81439
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp.
Los Angeles, California

81590
Korry Mfg. Co.
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82305
Palmer Electronics Corp.
South Gate, California

82389
Switchcraft Inc.
Chicago, Illinois

82415
North American Phillips
Controls Corp.
Frederick, Maryland

82872
Roanwell Corp.
New York, New York

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
Varo Inc.
Garland, Texas

83058
Carr Co., The United Can Div.
of TRW
Cambridge, Massachusetts

83298
Bendix Corp.
Electric Power Division
Eatontown, New Jersey

83330
Smith, Herman H., Inc.
Brooklyn, New York

83478
Rubbercraft Corp. of America, Inc.
West Haven, Connecticut

83594
Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740
Union Carbide Corp.
Battery Products Div.
formerly Consumer Products Div.
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
TRW Capacitors
Ogallala, Nebraska

84613
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Industrial Wire Div.
Peabody, Massachusetts

86577
Precision Metal Products,
of Malden Inc.
Stoneham, Massachusetts

86684
Radio Corp. of America
Electronic Components Div.
Harrison, New Jersey

86928
Seastrom Mfg. Co., Inc.
Glendale, California

87034
Illuminated Products Inc.
Subsidiary of Oak Industries Inc.
Anahiem, California

88219
Gould Inc.
Industrial Div.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Federal Pacific Co.
Fuquay-Varian, North Carolina

88486
Plastic Wire & Cable
Jewitt City, Connecticut

88690
Replaced by 04217

89536
Fluke, John Mfg. Co., Inc.
Seattle, Washington

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

90201
Mallory Capacitor Co. Div of
P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211 - use 56365
Square D Co.
Chicago, Illinois

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

90303
Mallory Battery Co.
Div. of Mallory Co., Inc.
Tarrytown, New York

91094
Essex International Inc.
Suglex/IWP Div.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91407
Replaced by 58474

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

91737 - use 71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co., Inc.
Tuckahoe, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co., Inc.
Div of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145
Replaced by 49956

94154 - use 94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp.
Lester, Pennsylvania

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95264
Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
Rolling Meadows, Illinois

95712
Bendix Corp.
Electrical Components Div.
Microwave Devices Plant
Franklin, Indiana

95987
Weckesser Co. Inc.
Chicago, Illinois

96733
San Fernando Electric Mfg. Co.
San Fernando, California

96853
Gulton Industries Inc.
Measurement and Controls Div.
formerly Rustrak Instruments Co.
Manchester, New Hampshire

96881
Thomson Industries, Inc.
Manhasset, New York

97540
Master Mobile Mounts
Div. of Whitehall Electronics Corp.
Ft. Meyers, Florida

97913
Industrial Electronic Hdware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdot Co., Inc.
Connector & Cable Div.
Pasadena, California

98291
Sealectro Corp.
Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98743
Replaced by 12749

98925
Replaced by 14433

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect. Comp. Div.
formerly Southern Elect. Div.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Div. of ITT Jennings formerly
Marshall Industries Capacitor Div.
Monrovia, California

99779 - use 29587
Bunker-Ramo Corp.
Barnes Div.
Landsdowne, Pennsylvania

99800
American Precision Industries Inc.
Delevan Division
East Aurora, New York

99942
Centrelab Semiconductor
Centrelab Electronics Div. of
Globe-Union Inc.
El Monte, California

Toyo Electronics
(R-Ohm Corp.)
Irvine, California

National Connector
Minneapolis, Minnesota

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Tel. (213) 849-4641
**Santa Clara**
Fluke Western Technical Center
Tom Marshall, Service Manager
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Tel. (408) 985-1200

**COLORADO**
**Denver**
Fluke Southwestern Tech. Ctr.
Roy Smith, Service Manager
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Fluke S.E. Technical Center
Jesse Morse, Service Manager
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Zip: 32803
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**ILLINOIS**
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**MARYLAND**
**Kensington**
Fluke Mideastern Tech. Ctr.
John Hines, Service Manager
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Zip: 20795
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John Fluke Mfg. Co., Inc.
Bill Fetrow, Tech. Service Spvr.
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Tel. (206) 774-2206

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**Calgary**
Fluke Canadian Technical Center
Ed Zahodnik, Service Manager
3829 12th St. N.E.
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**Mississauga**
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**QUEBEC**
**Longueuil**
Fluke Canadian Technical Center
Mel Richard, Service Manager
1330 Marie Victorian Blvd. E.
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Gottfried-Keller-Gasse 2/9
A-1030 Vienna, Austria
Tel: (0222) 734294

**BELGIUM**
C. N. Rood S/A
37 Place de Jamblinne de Meux
B-1040 Brussels, Belgium
Tel: (02) 27352135

**CYPRUS**
Chris Radiovision Ltd.
P.O. Box 1989
Nicosia, Cyprus
Tel: 66121

**DENMARK**
Tage Olsen A/S
Teglvaerksgade 37
DK-2100 Copenhagen 0, Denmark
Tel: (01) 294800

**FINLAND**
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Teollisuustie 7
02700 Kauniainen, Finland
Tel: (080) 502255

**FRANCE**
M. B. Electronique S.A.
Rue Fourney
ZAC de BUC, France
Tel: (01) 9563130

**GERMAN FEDERAL REPUBLIC**
Fluke (Deutschland) GmbH
4-Dusseldorf
Meineckestrasse 53
West Germany
Tel: 211-450831

Fluke (Deutschland) GmbH
8000 Munich 80
Mutschellestrasse 1
West Germany
Tel: 089-433021

**GREECE**
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Representations Ltd.
10 Nympheou Street
Athens 615, Greece
Tel: (021) 7792320

**ISRAEL**
R.D.T. Electronics
Engineering Ltd.
46, Sokolov Street
Ramat Hasharon 47235, Israel
Tel: 483211

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Via Giuseppe Armellini No. 37
00143 Rome, Italy
Tel: (06) 5915551

Sistrel S.p.A.
Via Timavo 66
20099 Sesto S. Giovanni (Milan)
Italy
Tel: (02) 2485233

**NETHERLANDS**
C. N. Rood, B.V.
Cort van der Lindenstraat 11-13
Rijswijk ZH2280AA
Netherlands
Tel: (070) 996360

**NORWAY**
Morgenstierne & Co. A/A
Konghellgate 3
P.O. Box 6688, Rodelokka
Oslo 5, Norway
Tel: (02) 356110

**PORTUGAL**
Equipamentos
De Laboratorio Ltda.
P.O. Box 1100
Lisbon 1, Portugal
Tel: (019) 976551

**SPAIN**
Ataio Ingenieros S.A.
Enrique Larreta 10-12
Madrid 16, Spain
Tel: (01) 7330562

**SWEDEN**
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P.O. Box 490
S-162 Vallingby-4
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Tel: (08) 380370

**SWITZERLAND**
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Jenatschstrasse 1
8002 Zurich, Switzerland
Tel: (01) 360711

**TURKEY**
Erkman Electronik Aletler
Necatibey Cad 92/2
Karakoy/Istanbul
Turkey
Tel: 441546

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Fluke International Corp.
Garnet Close
Watford WD2 4TT, England
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Elmeasco Instruments Pty. Ltd.
P.O. Box 30
Concord, N.S.W.
Australia 2137
Tel: (02) 736-2888

Elmeasco Instruments Pty. Ltd.
P.O. Box 107
Mt. Waverly, VIC 3149
Australia
Tel: 233-4044

**BOLIVIA**
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Casilla 7295
La Paz, Bolivia
Tel: 40962

**BRAZIL**
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Sao Paulo S.P., Brazil
Tel: (67) 2393

**CHILE**
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Santiago, Chile
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**COLOMBIA**
Assistec Limitada
Apartado Aereo 12322
Bogota 1, Colombia
Tel: 419331

**ECUADOR**
Proteco Coasin CIA, Ltda.
Apartado 228A
Quito, Ecuador
Tel: 526759

**HONG KONG**
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P.O. Box 56
Hong Kong
Tel: 794266

**INDIA**
Hinditron Services Pvt. Ltd.
69/A.L. Jagmohandas Marg
Bombay 400 006, India
Tel: 365344

**INDONESIA**
P.T. United Dico-Citas Co., Ltd.
JLN Penjaringen 39A
Jakarta, Indonesia
Tel: 21380

**IRAN**
Irantronix Company Ltd.
20 Salm Road, Roosevelt Avenue
Tehran, Iran
Tel: 828294

**JAPAN**
Panetron
1 Hizashikatamachi
Midori-Ku
Yokohama 226, Japan

John Fluke Mfg. Co., Inc.
1 Higashikatamachi
Midori-Ku
Yokohama-Shi 226, Japan
Tel: (045) 473-5425
TLX: 3823-666 FLUKJP J

**JORDAN**
Trading & Agricultural
Development Co.
P.O. Box 567
Amman, Jordan
Tel: 23052

**KENYA**
Advanced Communications Ltd.
City House, Wabera Street
P.O. Box 30635
Nairobi, Kenya
Tel: 31955

**KOREA**
Shin Han Scientific Co., Ltd.
International P.O. Box 1250
Seoul, Korea
Tel: (76) 2761

**KUWAIT**
Tareq Company
P.O. Box Safat 20506
Kuwait, Arabian Gulf
Tel: 436100, 436045

**LEBANON**
General Marketing Trading &
Contracting Company
Anis Nsouli Street
Nsouli Building
P.O. Box 155,655
Beirut, Lebanon
Tel: 319383, 312061

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Kota Kinabalu, Sebah
East Malaysia
Tel: 54082

O'Connor's (Pte) Ltd.
P.O. Box 91
Petaling Jaya, Selangor
West Malaysia
Tel: 51563

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Eugenia 408
Department 1
Mexico 12, D.F.., Mexico
Tel: 5360910

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**PAKISTAN**
Pak International Operations
505 Muhammadi House
McLeod Road
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Karachi, Pakistan

**PERU**
Importaciones
y Representaciones
Electronicas S.A.
Avda, Franklin D. Roosevelt 105
Lima 1, Peru
Tel: 288650

**SAUDI ARABIA**
Electronic Equipment
Marketing Establishment
P.O. Box 3750
Riyadh, Saudi Arabia
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**SINGAPORE**
O'Connor's (Pte) Ltd.
98 Pasir Panjang Road
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P.O. Box 39797
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2018
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**TAIWAN**
Tatung Company
22 Chungshan North Road
3rd Sec.
Taipei, Taiwan
Republic of China

**THAILAND**
Dynamic Supply
Engineering R.O.P.
No. 56 Ekamai, Sukhumvit 63
Bankok 11, Thailand
Tel: 914434, 928532

**URUGUAY**
Coasin Uruguaya S.R.L.
Cerrito 617-4° Piso
Montevidio, Uruguay
Tel: 917978

**VENEZUELA**
Coasin C.A.
APDO Postal 50939
Sabana Grande No. 1
Caracas 105, Venezuela
Tel:

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Harry J. Lang & Associates
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**Phoenix**
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ISI Sales Group
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Tel. (408) 244-1505

### COLORADO
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Tel. (303) 750-1222

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IRI Sales Group
John Fluke Mfg. Co., Inc.
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### FLORIDA
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### GEORGIA
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2522 Tanglewood Road
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### HAWAII
**Honolulu**
EMC Corp.
2979 Ualena St.
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CCI Sales Group
Central Region Office
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John Fluke Mfg. Co., Inc.
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Zip: V7I 1E6
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800 Windmill Rd.
Burnside Industrial Park
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1299 Richmond Road
Zip: K2B 7Y4
Tel. (613) 829-9651

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1330 Marie Victorian Blvd. E.
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All of the above Fluke Sales Offices carry local stocks of low-cost Digital Multimeters (Models 8000A, 8030A, 8040A), Counters (Model 1900A), Digital Thermometers (Models 2160A, 2170A, 2165A, 2175A) and the Universal Temperature Probe (Model 80T-150). These same products are available from the following distributors:

**Brownell Electronics**
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# Section 8
# Schematic Diagrams


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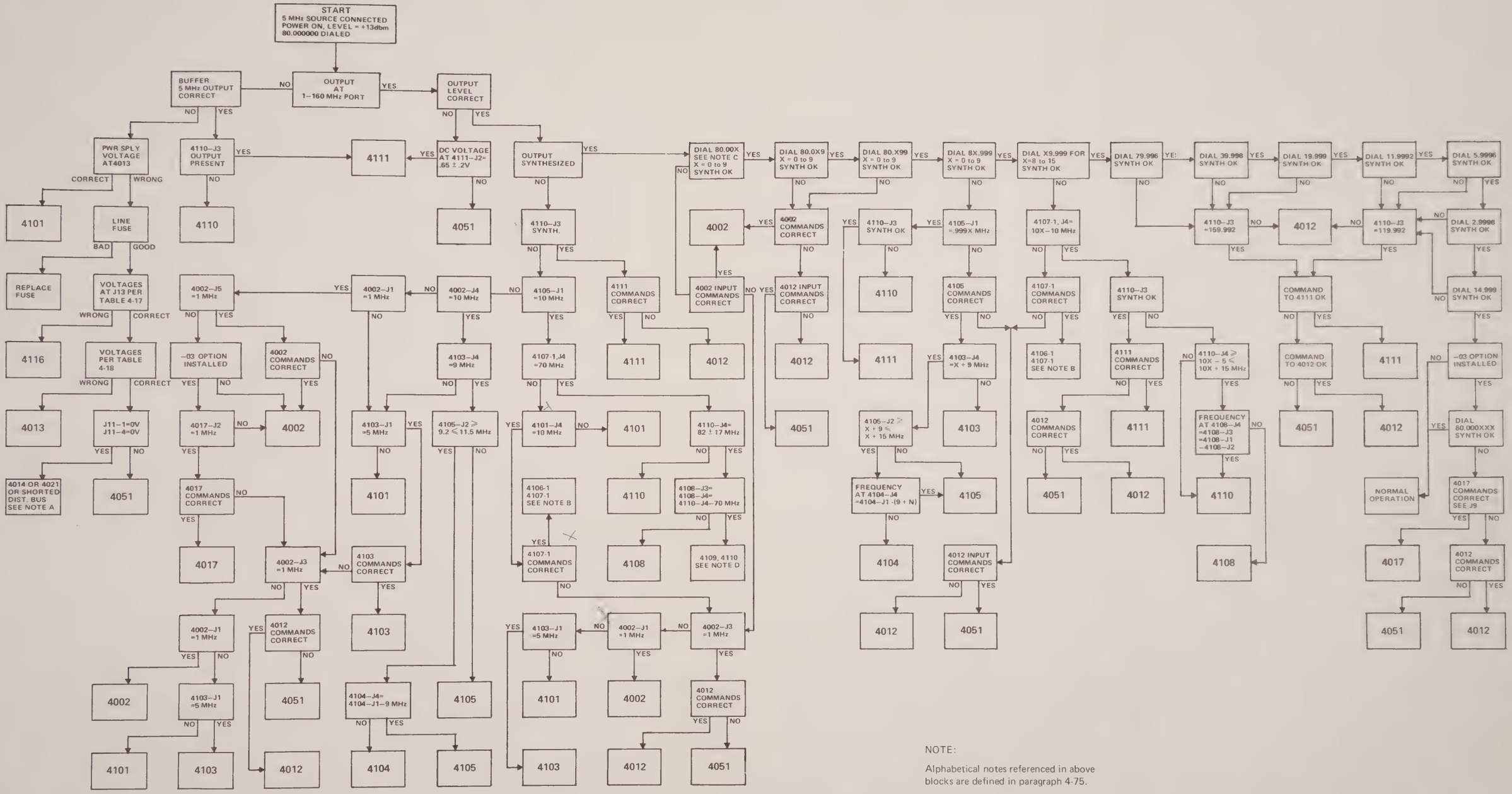
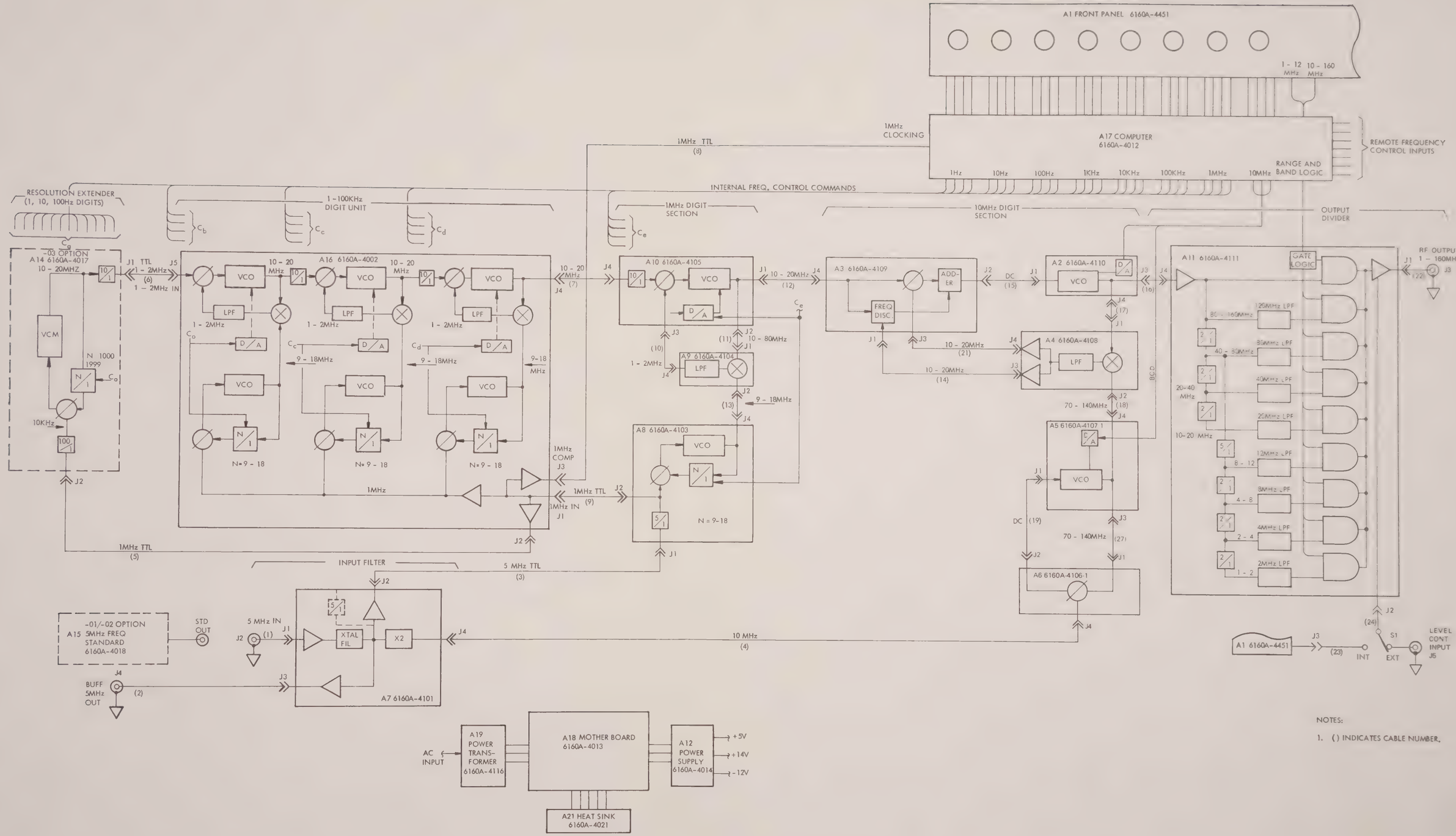
| 8-18. | A18 Internal Frequency Standard PCB Assembly - Option 02 | 6160A-1018 | 8-25 |




NOTE:

Alphabetical notes referenced in above blocks are defined in paragraph 4-75.

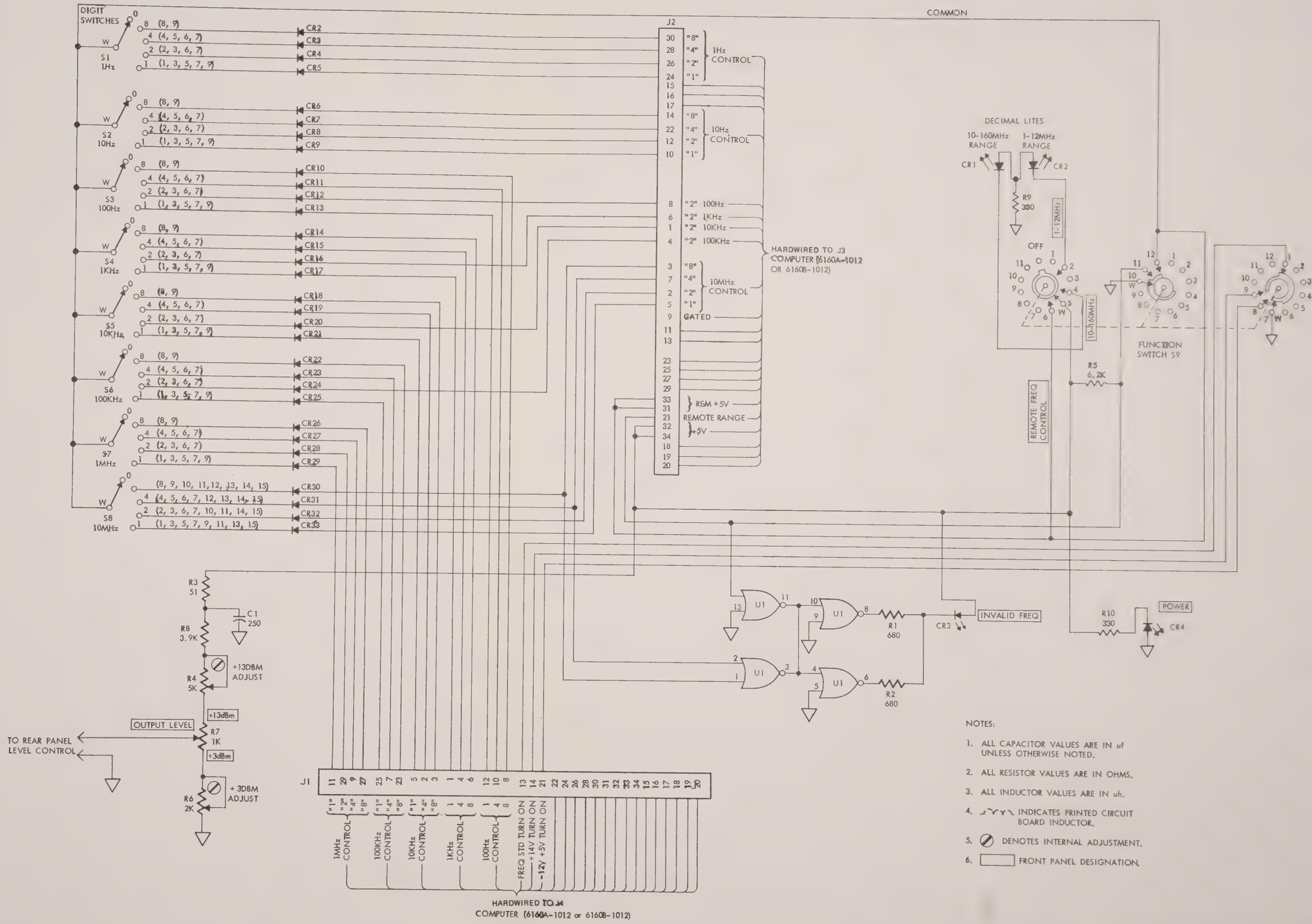
**FIGURE 8-1. MODEL 6160A TROUBLESHOOTING CHART (6160A-1600)**




NOTES:

1. ( ) INDICATES CABLE NUMBER.

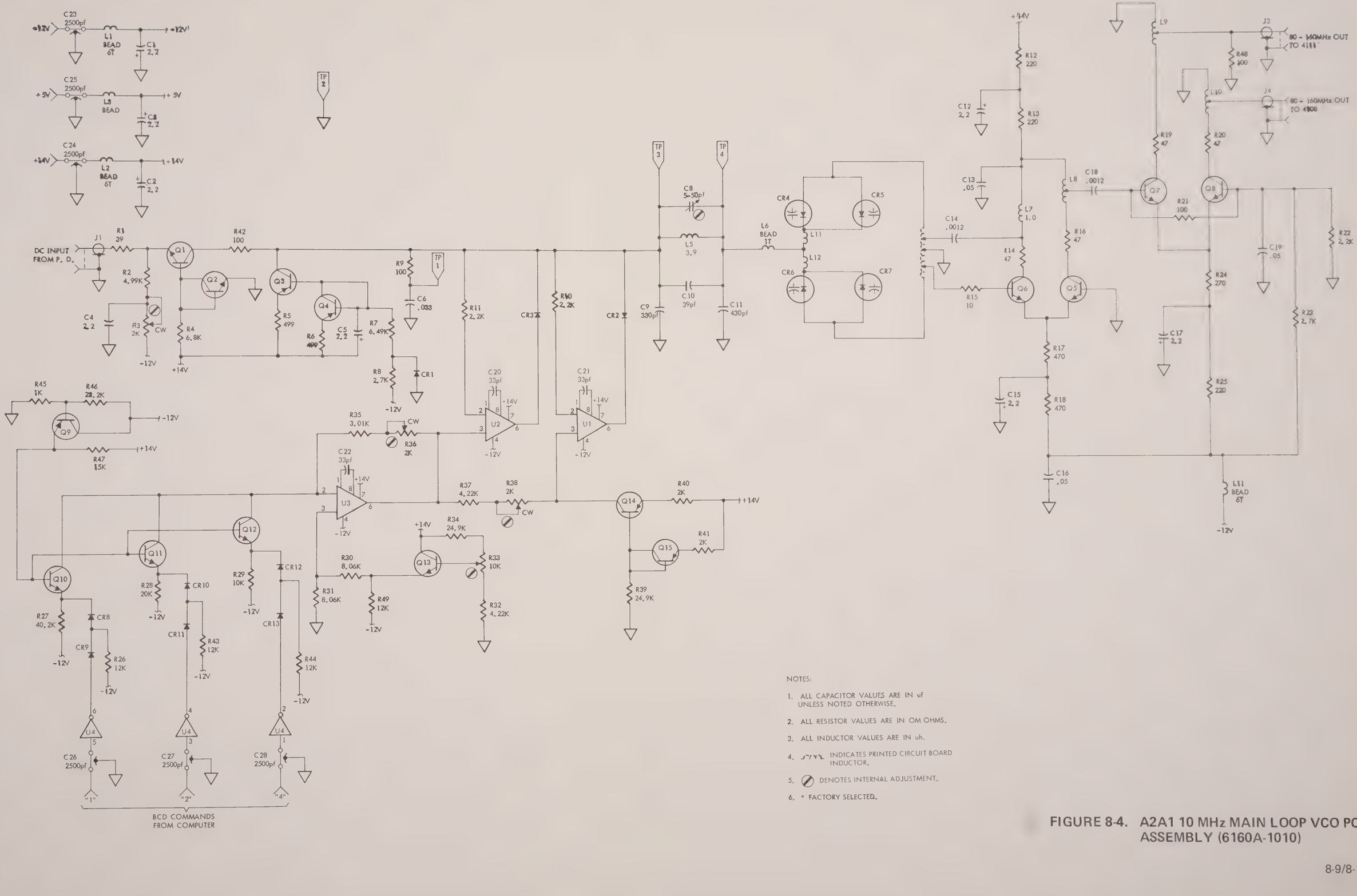
**FIGURE 8-2. MODEL 6160A BLOCK DIAGRAM (6160A-1501)**




NOTES:

1. ALL CAPACITOR VALUES ARE IN uf UNLESS OTHERWISE NOTED.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN uh.
4. INDICATES PRINTED CIRCUIT BOARD INDUCTOR.
5. DENOTES INTERNAL ADJUSTMENT.
6. FRONT PANEL DESIGNATION.

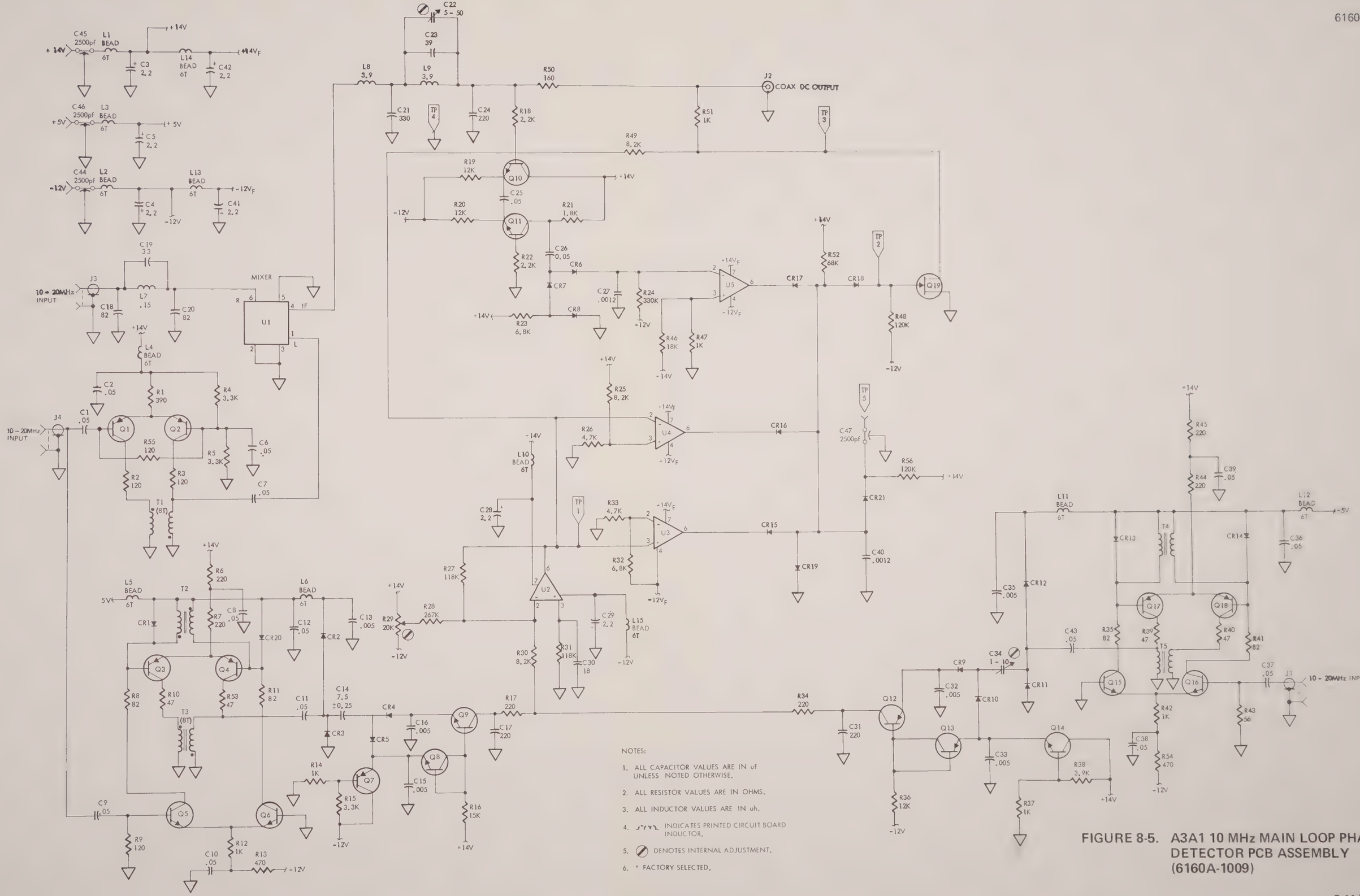
**FIGURE 8-3. A1A1 FRONT PANEL PCB ASSEMBLY (6160A-1051)**




NOTES:

1. ALL CAPACITOR VALUES ARE IN uf UNLESS NOTED OTHERWISE.
2. ALL RESISTOR VALUES ARE IN OM OHMS.
3. ALL INDUCTOR VALUES ARE IN uh.
4. ⌐¬ INDICATES PRINTED CIRCUIT BOARD INDUCTOR.
5. ⊘ DENOTES INTERNAL ADJUSTMENT.
6. * FACTORY SELECTED.

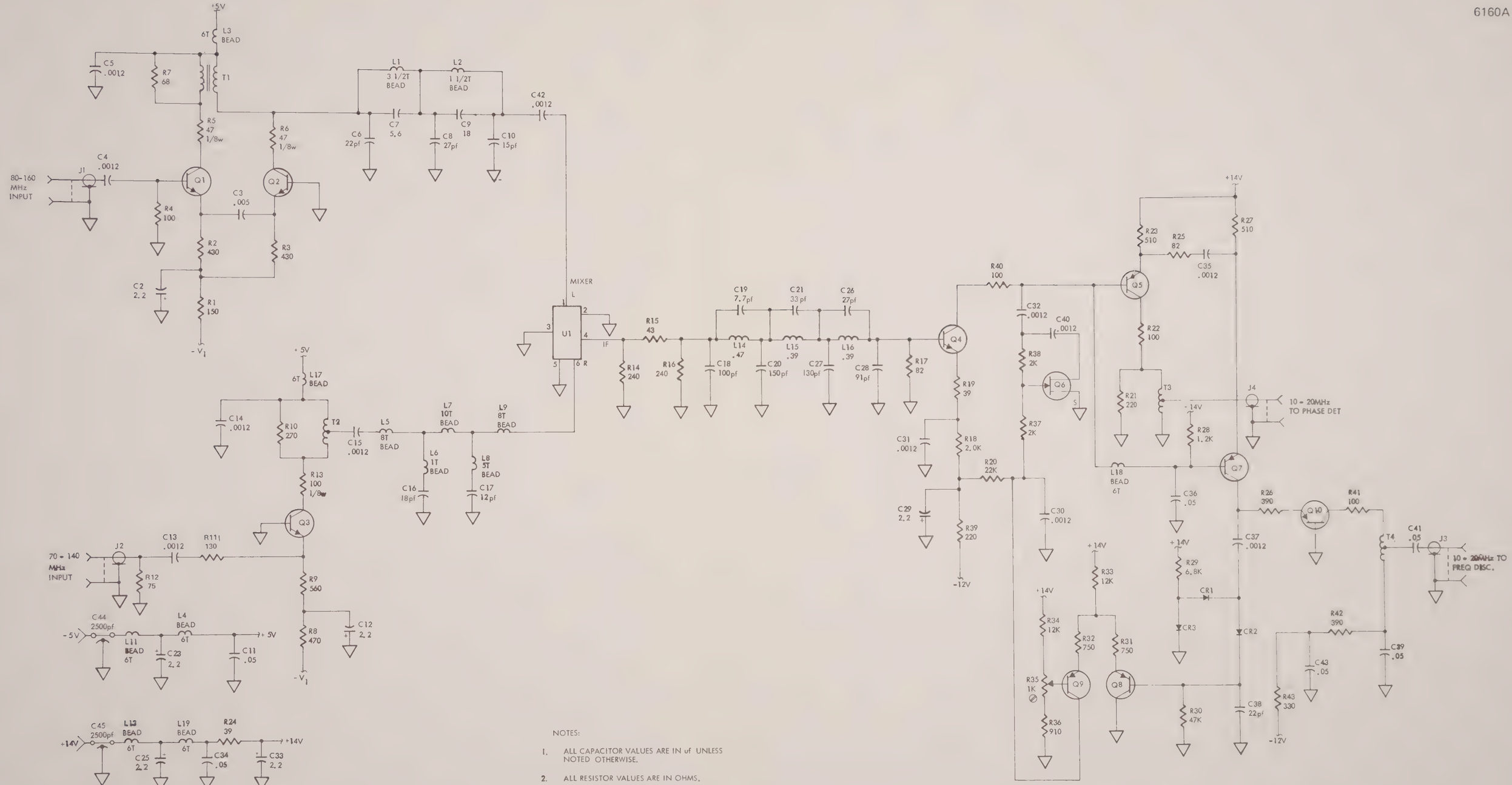
**FIGURE 8-4. A2A1 10 MHz MAIN LOOP VCO PCB ASSEMBLY (6160A-1010)**




NOTES:

1. ALL CAPACITOR VALUES ARE IN uf UNLESS NOTED OTHERWISE.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN uh.
4. INDICATES PRINTED CIRCUIT BOARD INDUCTOR.
5. DENOTES INTERNAL ADJUSTMENT.
6. * FACTORY SELECTED.

**FIGURE 8-5. A3A1 10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY (6160A-1009)**




NOTES:

1. ALL CAPACITOR VALUES ARE IN uf UNLESS NOTED OTHERWISE.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN uh.
4. ⌇⌇⌇ INDICATES PRINTED CIRCUIT BOARD INDUCTOR.
5. ⊘ DENOTES INTERNAL ADJUSTMENT.
6. * FACTORY SELECTED.

FIGURE 8-6. A4A1 10 MHz I.F. MIXER PCB ASSEMBLY (6160A-1008)

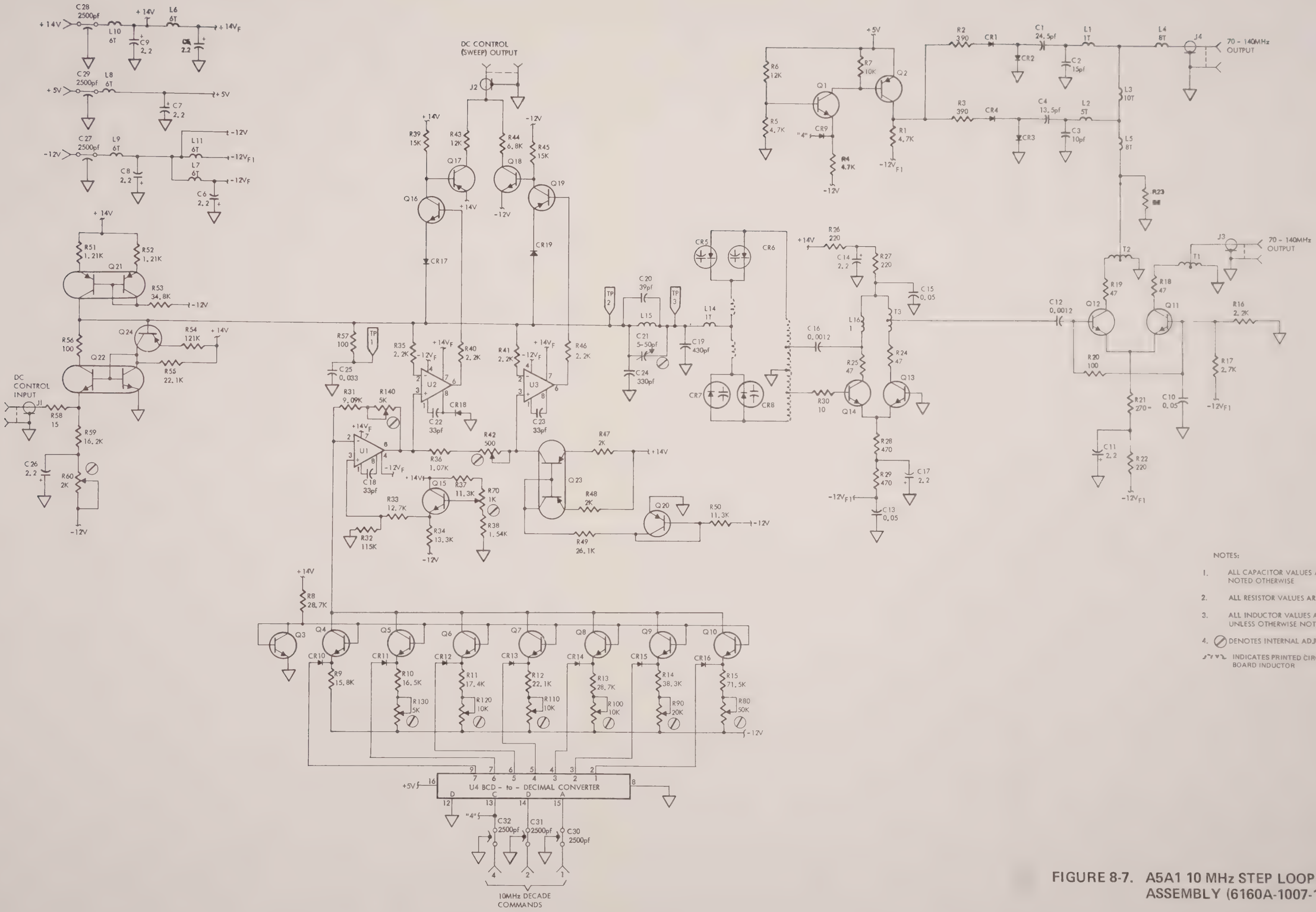

DC CONTROL (SWEEP) OUTPUT
DC CONTROL INPUT
70 - 140MHz OUTPUT
70 - 140MHz OUTPUT
10MHz DECADE COMMANDS
U4 BCD - to - DECIMAL CONVERTER
NOTES:
1. ALL CAPACITOR VALUES ARE IN uf UNLESS NOTED OTHERWISE
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN uh UNLESS OTHERWISE NOTED.
4. DENOTES INTERNAL ADJUSTMENT
INDICATES PRINTED CIRCUIT BOARD INDUCTOR

FIGURE 8-7. A5A1 10 MHz STEP LOOP VCO PCB ASSEMBLY (6160A-1007-1)

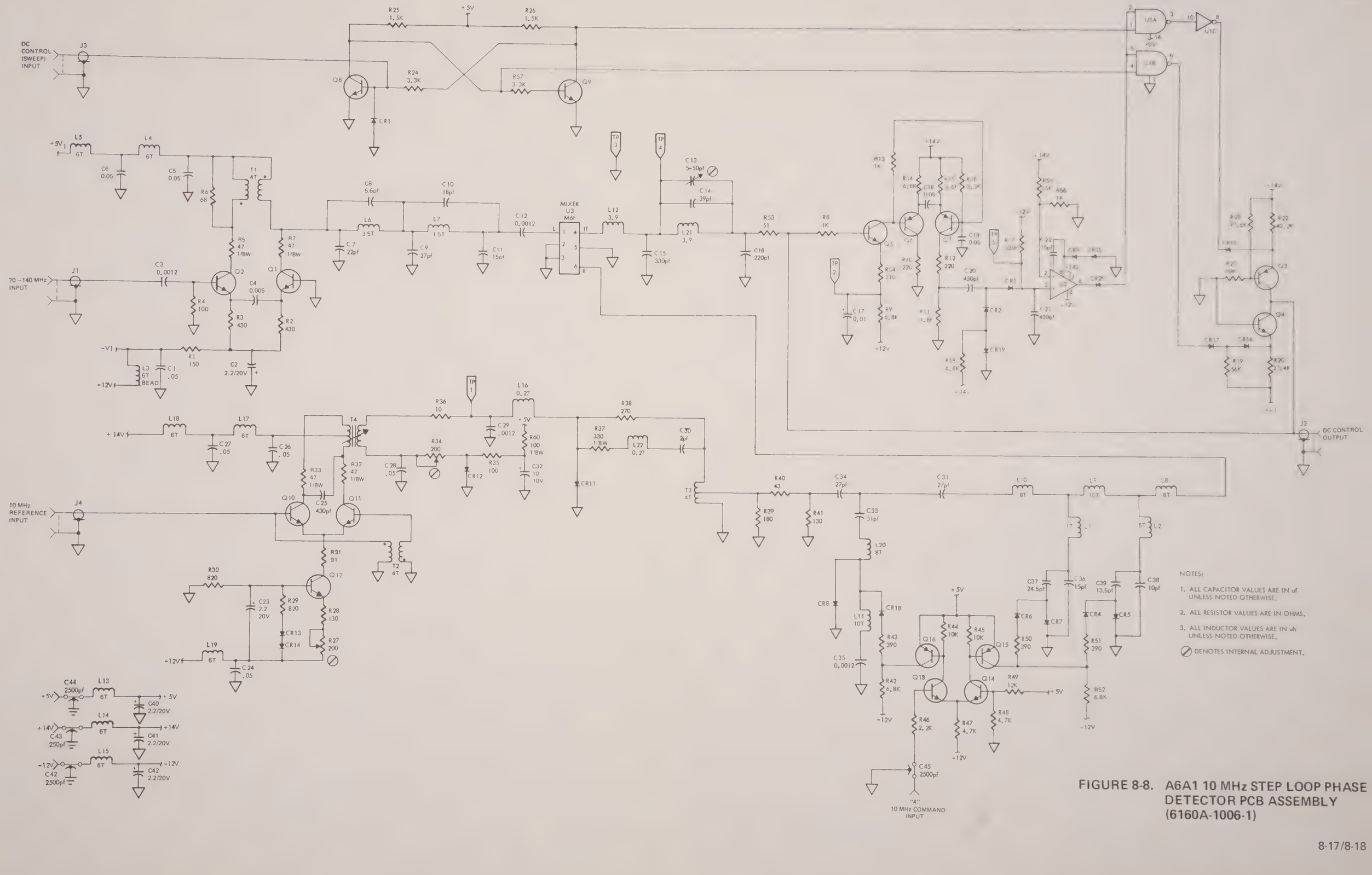
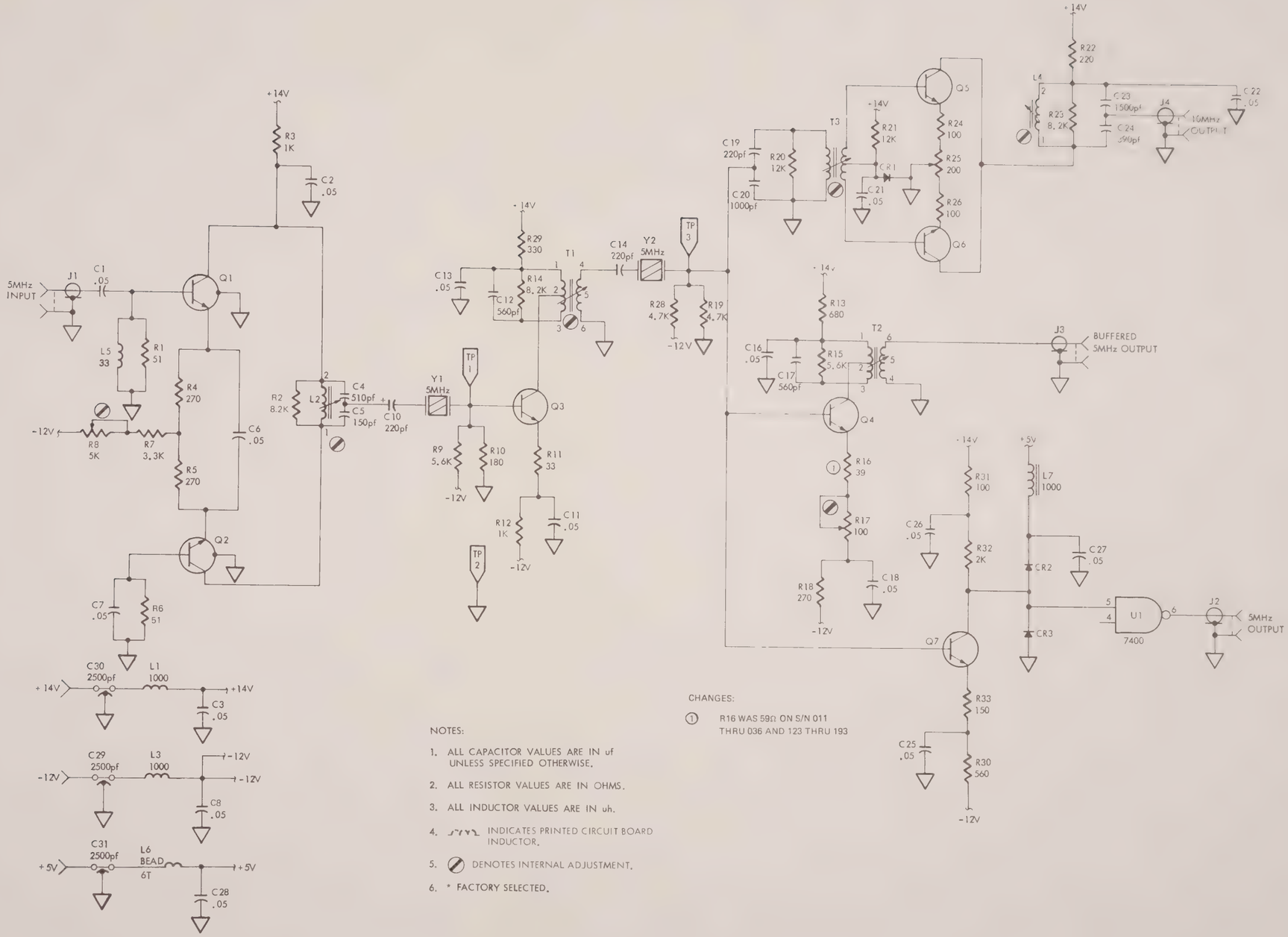



**FIGURE 8-8. A6A1 10 MHz STEP LOOP PHASE DETECTOR PCB ASSEMBLY (6160A-1006-1)**




NOTES:

1. ALL CAPACITOR VALUES ARE IN uf UNLESS SPECIFIED OTHERWISE.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN uh.
4. ⌐˜˜˜

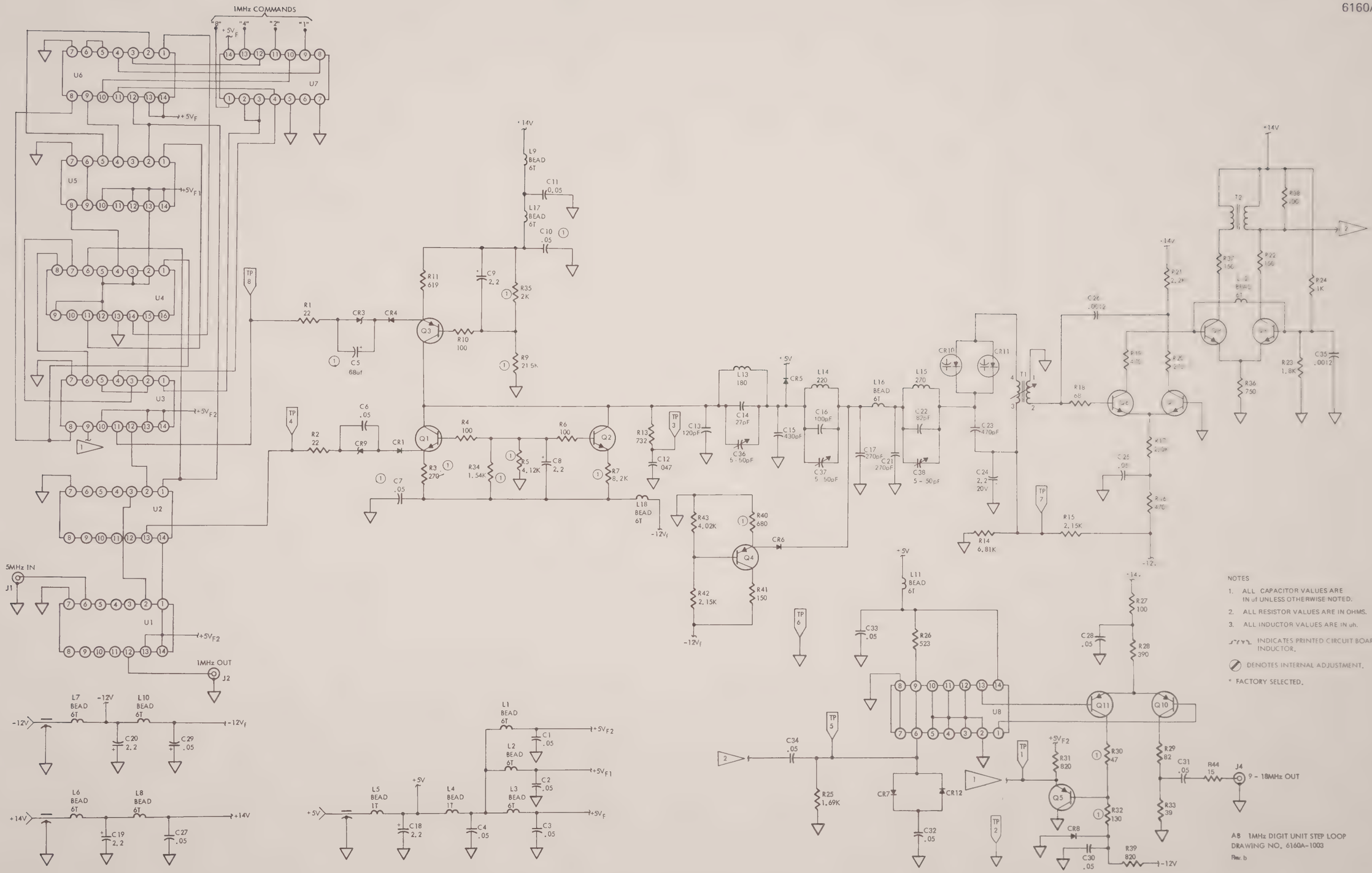
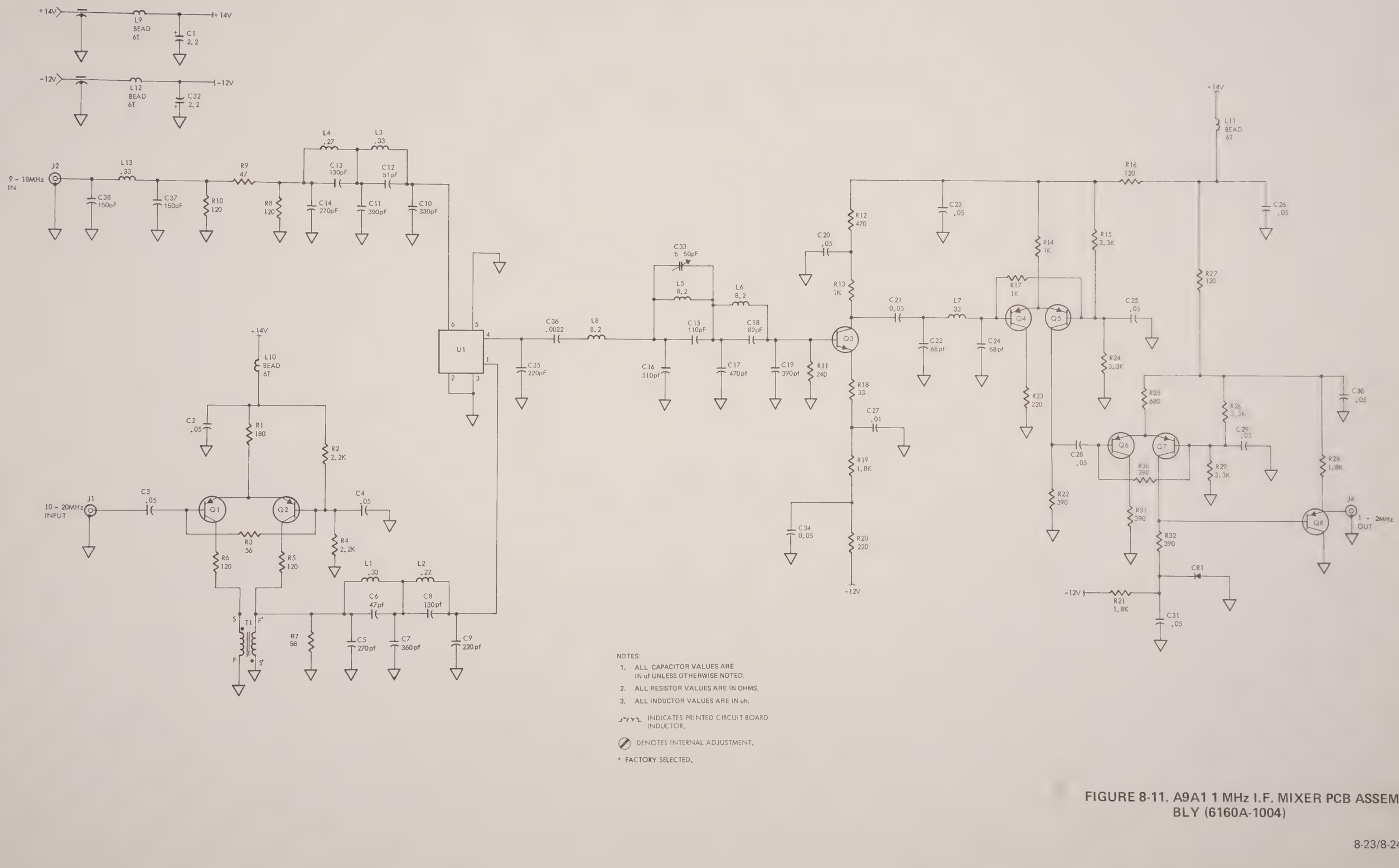



FIGURE 8-10. A8A1 1 MHz STEP LOOP PCB ASSEMBLY (6160A-1003)




NOTES:

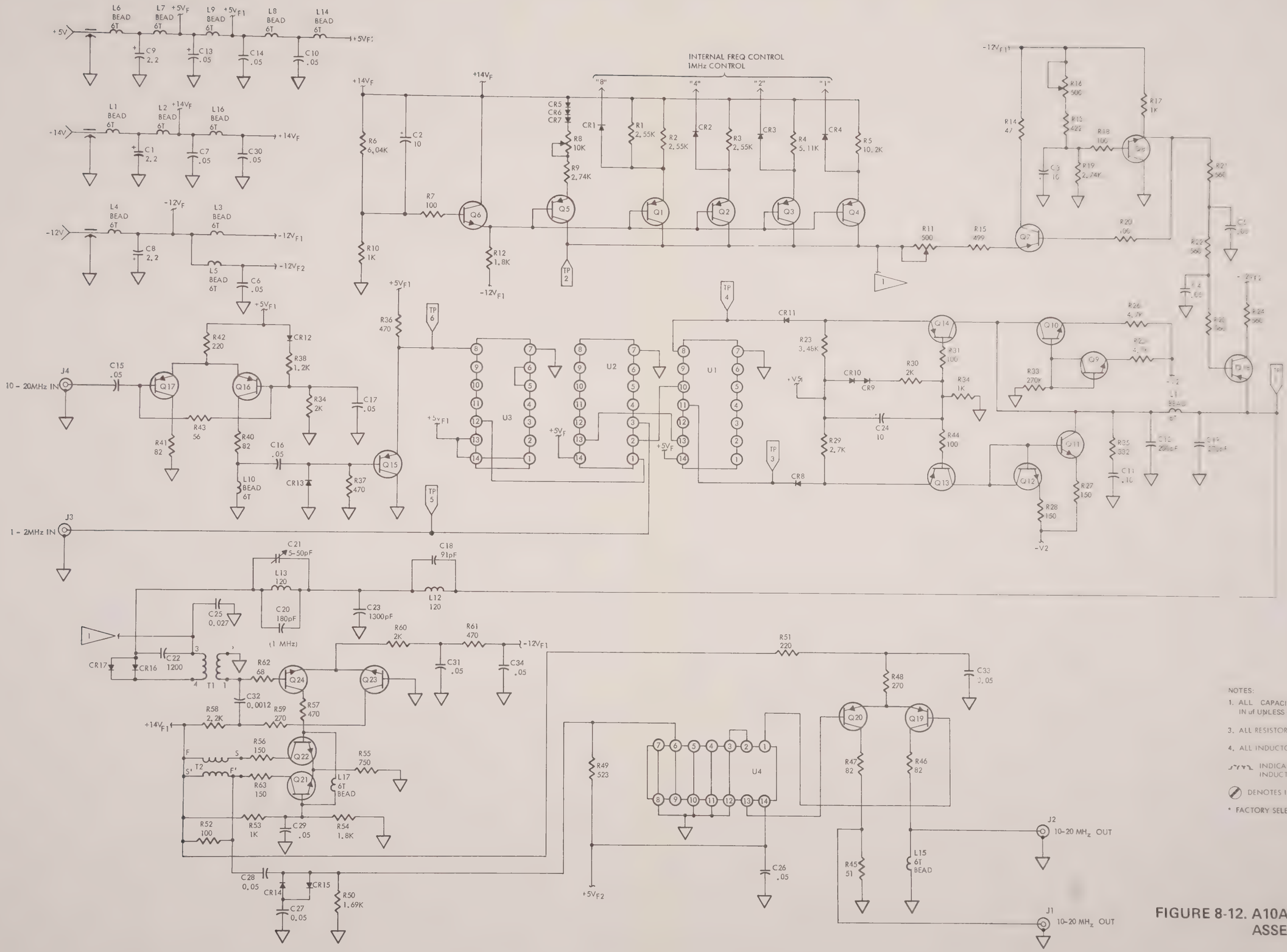
1. ALL CAPACITOR VALUES ARE IN uf UNLESS OTHERWISE NOTED.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN uh.

INDICATES PRINTED CIRCUIT BOARD INDUCTOR.

DENOTES INTERNAL ADJUSTMENT.

* FACTORY SELECTED.

**FIGURE 8-11. A9A1 1 MHz I.F. MIXER PCB ASSEMBLY (6160A-1004)**




NOTES:

1. ALL CAPACITOR VALUES ARE IN uf UNLESS OTHERWISE NOTED.
3. ALL RESISTOR VALUES ARE IN OHMS.
4. ALL INDUCTOR VALUES ARE IN uh.

INDICATES PRINTED CIRCUIT BOARD INDUCTOR.

DENOTES INTERNAL ADJUSTMENT.

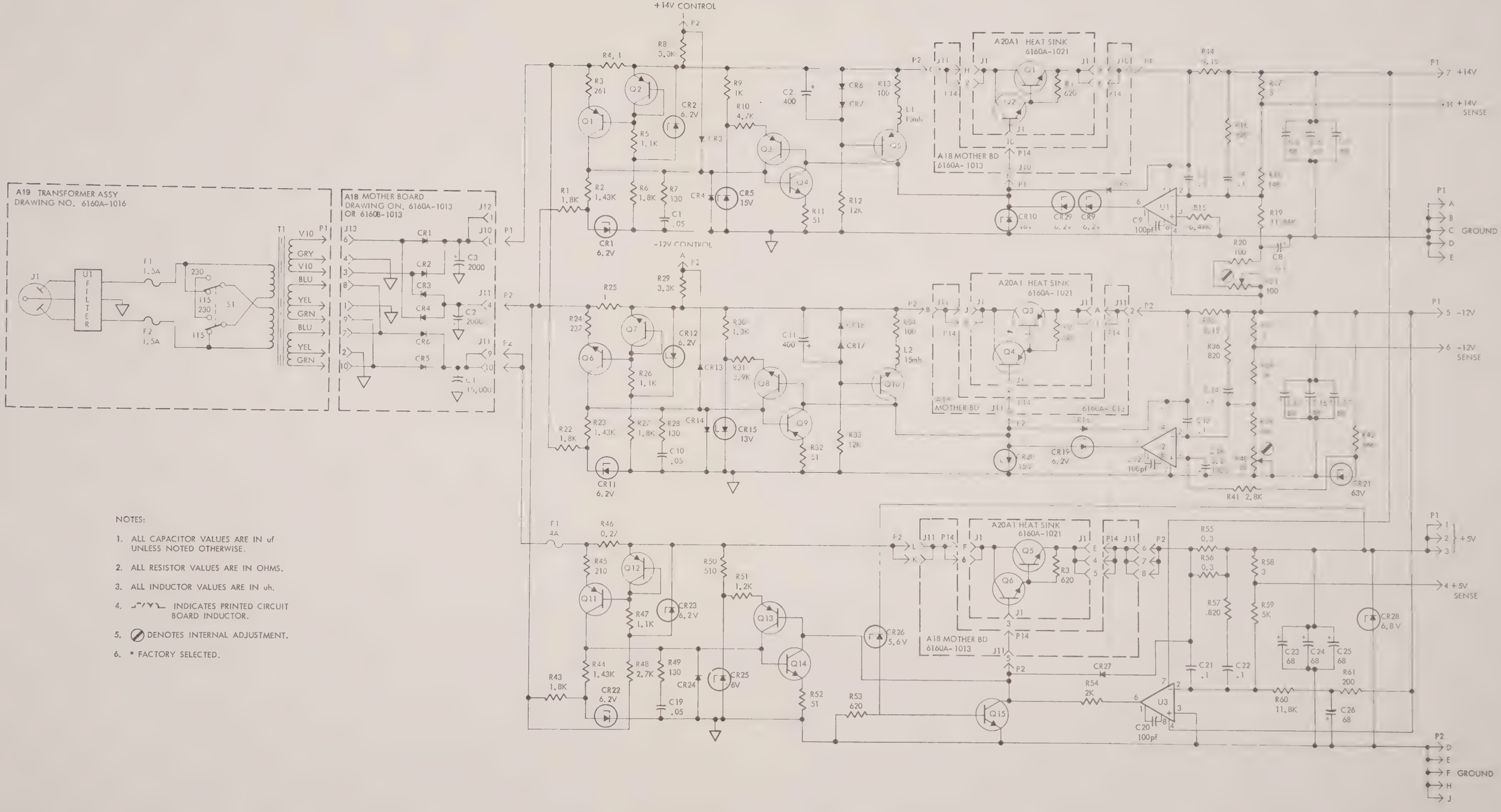
* FACTORY SELECTED.

**FIGURE 8-12. A10A1 1 MHz MAIN LOOP PCB ASSEMBLY (6160A-1005)**

NOTES:

1. ALL CAPACITOR VALUES ARE IN uf UNLESS NOTED OTHERWISE.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN uh.
4. ⌇⌇⌇ INDICATES PRINTED CIRCUIT BOARD INDUCTOR.
5. ⊘ DENOTES INTERNAL ADJUSTMENT.
6. * FACTORY SELECTED.

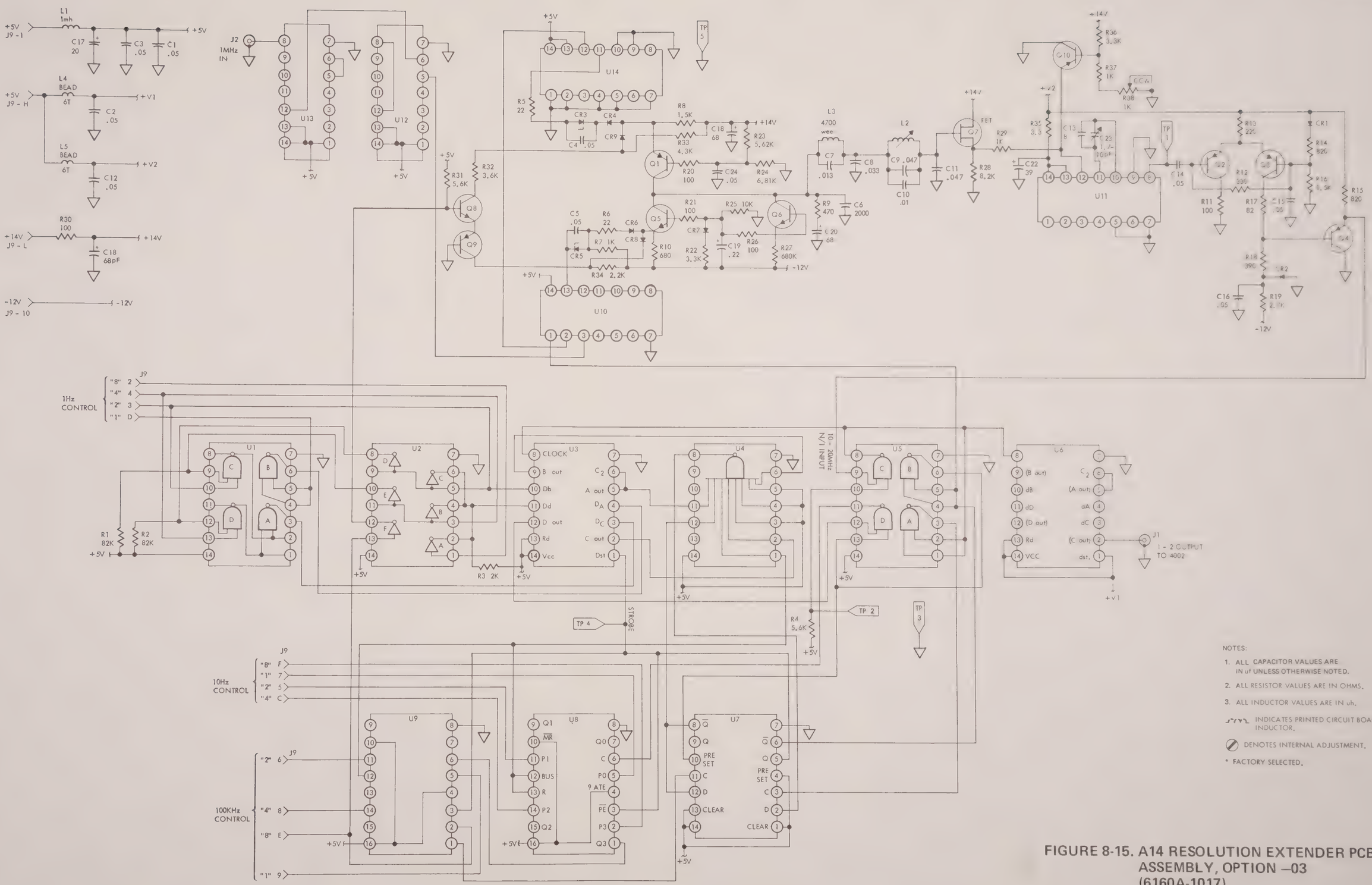
FIGURE 8-13. A11A1 OUTPUT DIVIDER PCB ASSEMBLY (6160A-1011)




NOTES:

1. ALL CAPACITOR VALUES ARE IN uf UNLESS NOTED OTHERWISE.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN uh.
4. ⌐⁀⁀⁀¬ INDICATES PRINTED CIRCUIT BOARD INDUCTOR.
5. ⊘ DENOTES INTERNAL ADJUSTMENT.
6. * FACTORY SELECTED.

FIGURE 8-14. A12 POWER SUPPLY PCB ASSEMBLY (6160A-1014)




NOTES:

1. ALL CAPACITOR VALUES ARE IN uf UNLESS OTHERWISE NOTED.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN uh.

INDICATES PRINTED CIRCUIT BOARD INDUCTOR.

DENOTES INTERNAL ADJUSTMENT.

* FACTORY SELECTED.

**FIGURE 8-15. A14 RESOLUTION EXTENDER PCB ASSEMBLY, OPTION –03 (6160A-1017)**

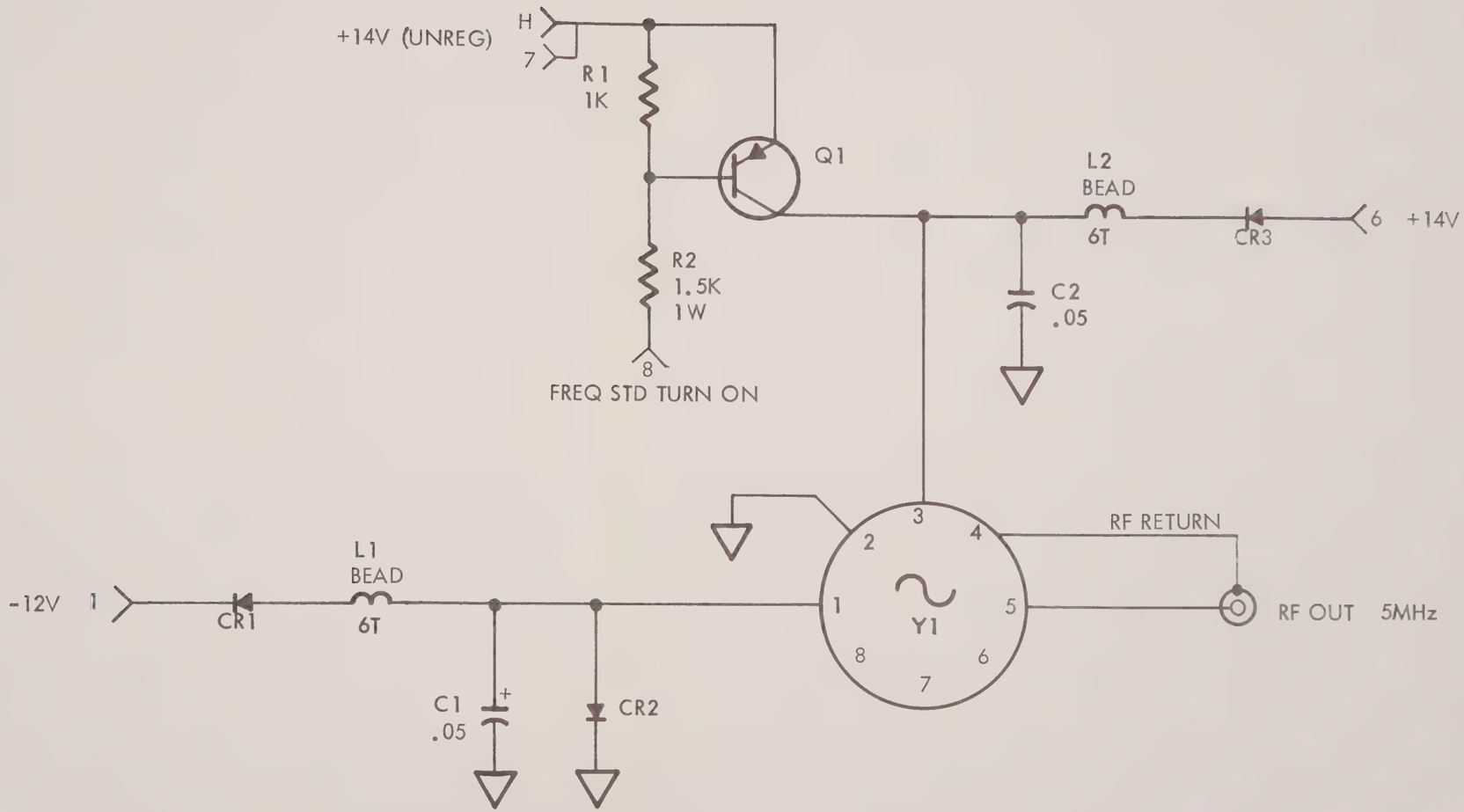



FIGURE 8-16. A15 INTERNAL FREQUENCY STANDARD ASSEMBLY, OPTION –01, –02 (6160A-1018)

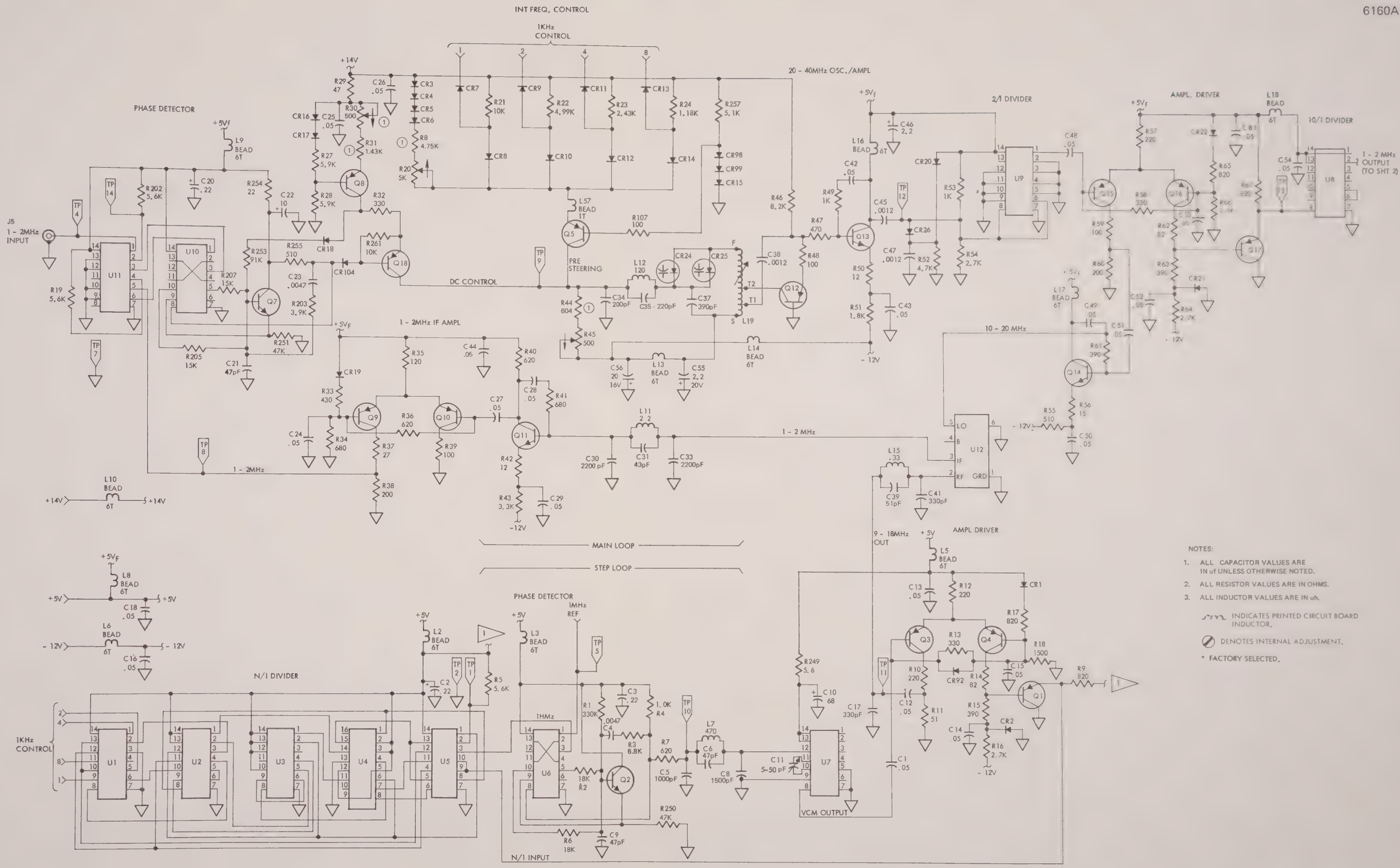



FIGURE 8-17. (1 of 3) A16 1 - 100 kHz DIGIT UNIT PCB ASSEMBLY (6160A-1002)

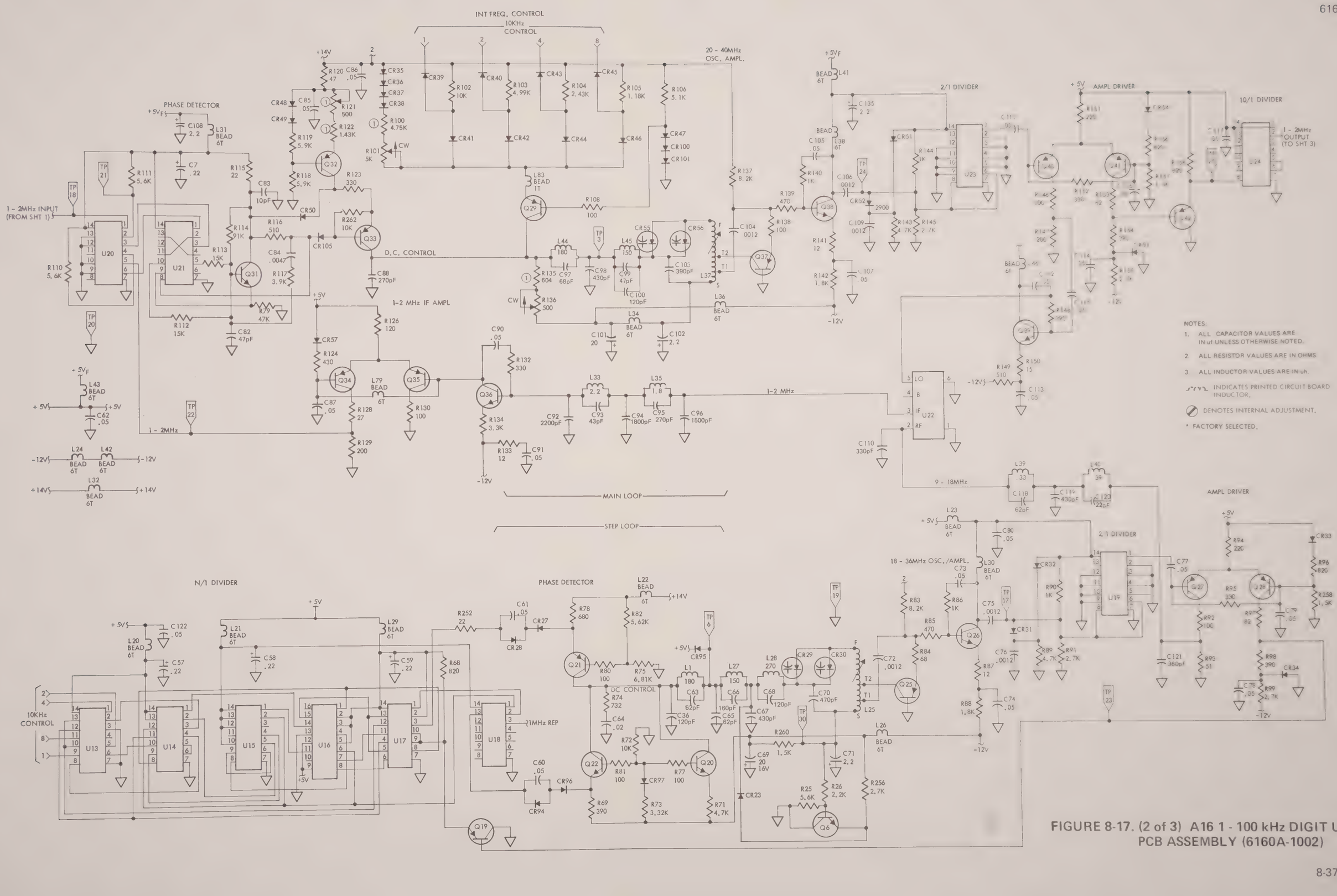
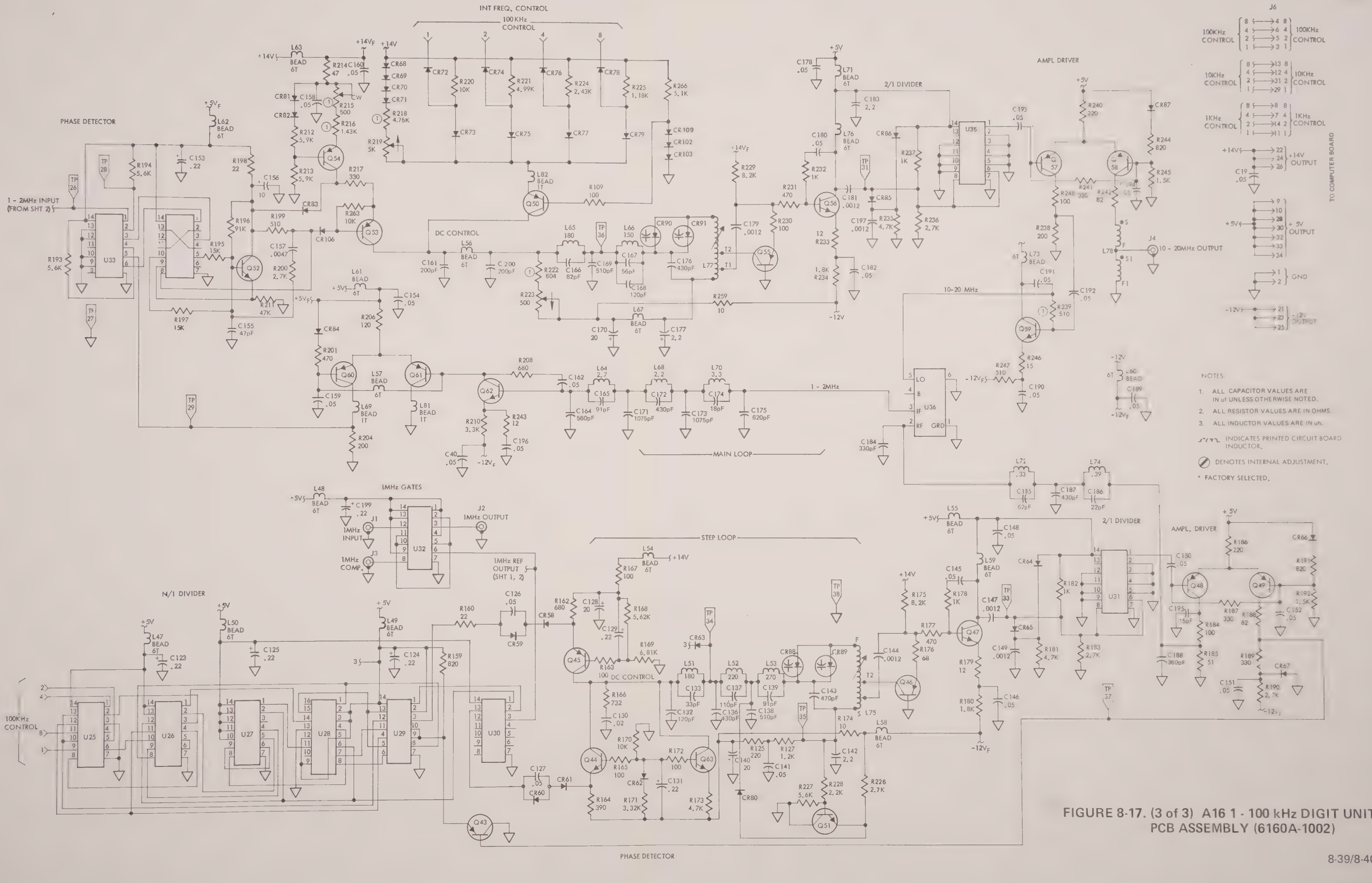



FIGURE 8-17. (2 of 3) A16 1 - 100 kHz DIGIT UNIT PCB ASSEMBLY (6160A-1002)




NOTES:

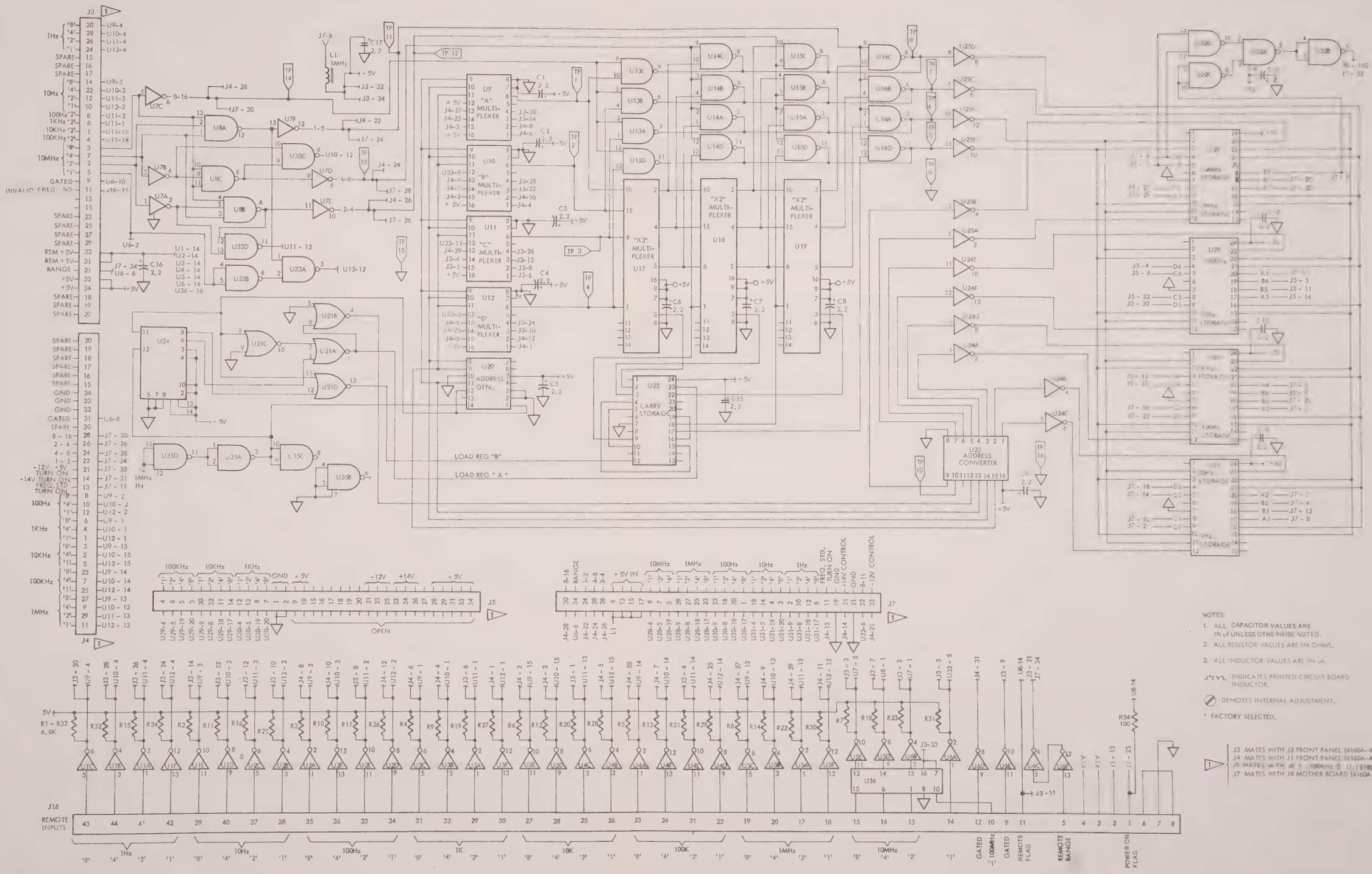
1. ALL CAPACITOR VALUES ARE IN uf UNLESS OTHERWISE NOTED.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN uh.

INDICATES PRINTED CIRCUIT BOARD INDUCTOR.

DENOTES INTERNAL ADJUSTMENT.

* FACTORY SELECTED.

FIGURE 8-17. (3 of 3) A16 1 - 100 kHz DIGIT UNIT PCB ASSEMBLY (6160A-1002)




NOTES:

1. ALL CAPACITOR VALUES ARE IN uf UNLESS OTHERWISE NOTED.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN uh.

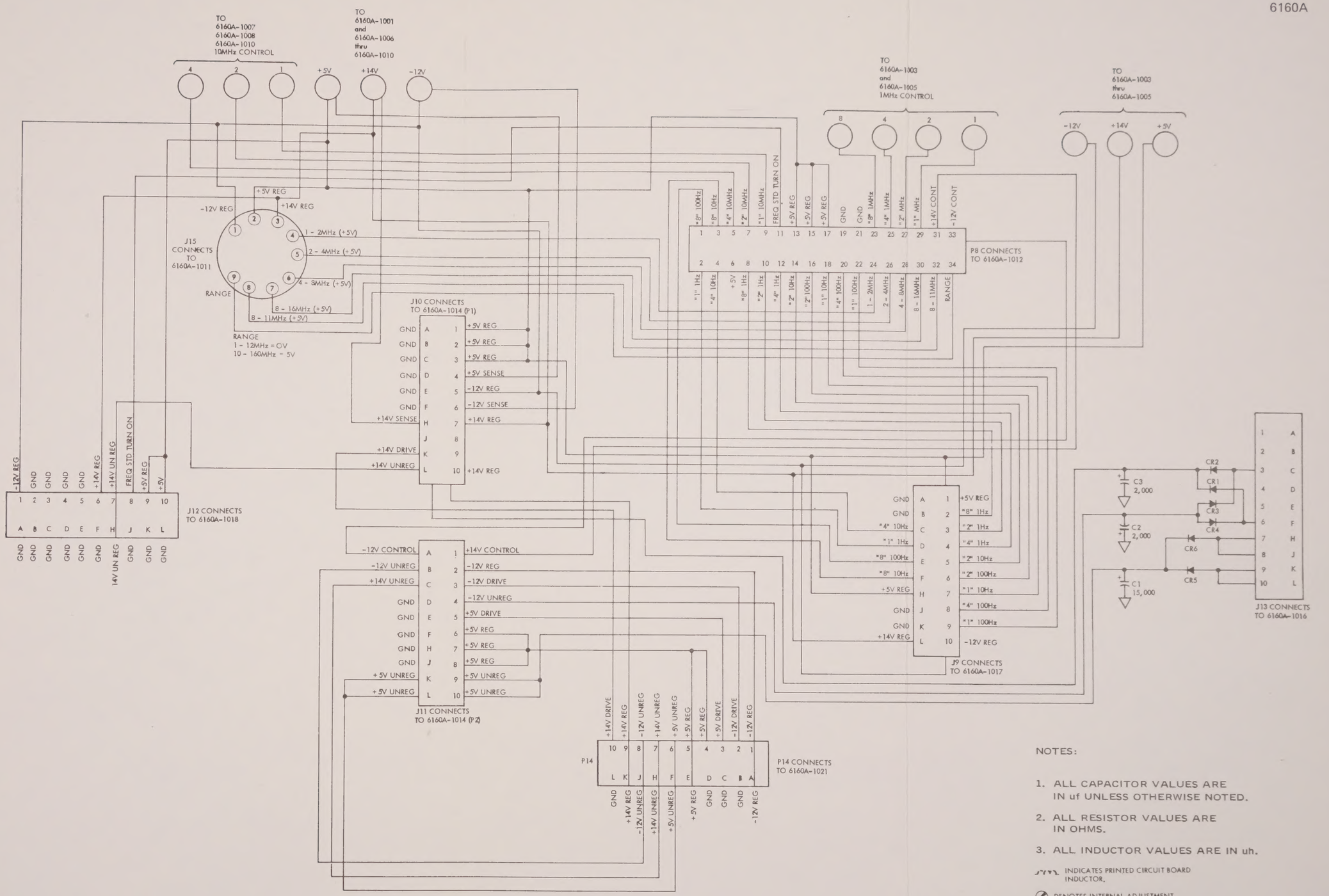
INDICATES PRINTED CIRCUIT BOARD INDUCTOR.

DENOTES INTERNAL ADJUSTMENT.

* FACTORY SELECTED.

J3 MATES WITH J2 FRONT PANEL (6160A-4051)
J4 MATES WITH J1 FRONT PANEL (6160A-4051)
J5 MATES WITH J6 ( 100KHz ) U.I. (6160A-4002)
J7 MATES WITH J8 MOTHER BOARD (6160A-4013)

FIGURE 8-18. A17 COMPUTER PCB ASSEMBLY (6160A-1012)




NOTES:

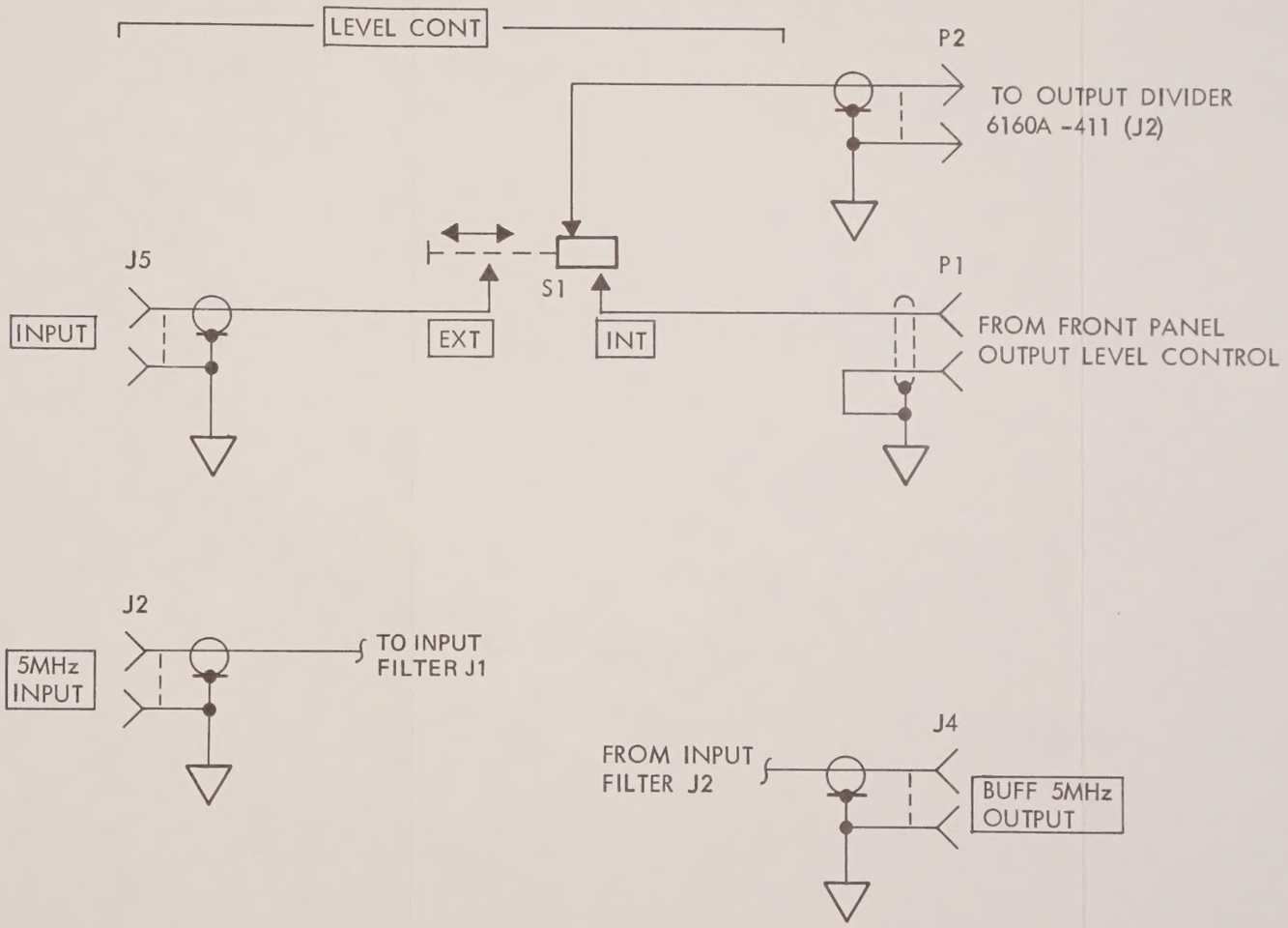
1. ALL CAPACITOR VALUES ARE IN uf UNLESS OTHERWISE NOTED.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN uh.

INDICATES PRINTED CIRCUIT BOARD INDUCTOR.

DENOTES INTERNAL ADJUSTMENT.

* FACTORY SELECTED.

FIGURE 8-19. A18 MOTHER BOARD PCB ASSEMBLY (6160A-1013)




NOTES:

1. [ ] REAR PANEL DESIGNATION

FIGURE 8-20. A20 REAR PANEL ASSEMBLY (6160A-1052)

MP MASTER
MA30850